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ENVIRONMENTAL AND EXPLORATION PROGRAM

SUMMARY REPORT # 8
(Through August 31, 1976)

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U. S. DEPARTMENT OF THE INTERIOR

PROTOTYPE OIL SHALE LEASING PROGRAM

TRACT C-b

SUMMARY REPORT #8

(Through August 31, 1976)

Submitted to:

Mr. Peter A. Rutledge
Area Oil Shale Supervisor
Conservation Division
U. S. Geological Survey
Grand Junction, Colorado

By:

C-b Shale Oil Project

Ashland Oil, Inc.
Shell Oil Company, Operator

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TRACT C-b
SUMMARY REPORT #8
(Through August 31, 1976)

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INTRODUCTION

Summary Report #8 and Quarterly Data Report #8 cover the eighth quarter of exploration and environmental data for the Environmental Baseline Program of Tract C-b. These reports specifically cover the summer quarter of June 1976 through August 1976. Quarterly Data Report #8 consists of four volumes of the comprehensive data collected for Tract C-b and submitted to the Area Oil Shale Supervisor in Grand Junction on October 15, 1976. The purpose of Summary Report #8 is to provide the reader with a general overview of the information included in Quarterly Data Report #8. For a complete review of Tract activities to date, reports from all quarters must be consulted. Parties interested in the project can review these volumes by contacting the Area Oil Shale Supervisor's Office. For ready reference, the reader is reminded that both outline and section numbering in summary and quarterly data reports are identical.

Although this summary report reviews the eighth quarter of reporting, the two year Environmental Baseline Program does not end until October 31, 1976. Therefore there will be one more data report, Quarterly Data Report #9, covering the data collected during September and October, 1976. A Summary Report #9 will not be issued, however. All summarization and conclusions that normally would be included in the summary report will be integrated into the Final Environmental Baseline Report which will cover the data collected over the two year program.

I

PRE-EXPLORATION ENVIRONMENTAL RECONNAISSANCE SURVEYS

No environmental reconnaissance surveys were conducted during this quarter. The results of previous surveys are contained in Quarterly Data Reports #1 and #2 and are summarized in Summary Reports #1 and #2.

II A HYDROLOGY AND WATER QUALITY

II A-1 Surface Streams

In this quarter some information was reported on each of the 13 surface water gauging stations shown in Figure II A-1. The data are preliminary and are subject to revision. They cover the water year beginning September 30, 1975. Tables presenting the various data may be found in Quarterly Data Report #8. The tables are grouped by water gauging station and identified in Table II A-1. Included in this report are Daily Gauge Height forms and sediment concentration information for all stations experiencing significant flow. At several stations little or no flow has been recorded since the beginning of the 1976 water year. These stations are:

09306015	No flow, except for four days in February and three days in March
09306028	No flow, except 13 days in February, four days in March, and one day in August
09306033	No flow, except four days in February, three days in April, two days in July, and one day in August
09306036	No flow, except for one day in July and one day in August
09306039	No flow, except for ten days in February, nine days in March, one day in July, and one day in August
09306042	No flow, except for two days in February
09306050	No flow, except for seven days in March
09306052	No flow, except for four days in February and two days in March

Tables II A-2 through II A-6 summarize the water quality information and are presented in the following pages. U. S. Geological Survey water quality data for three stations near the junction of Piceance Creek and

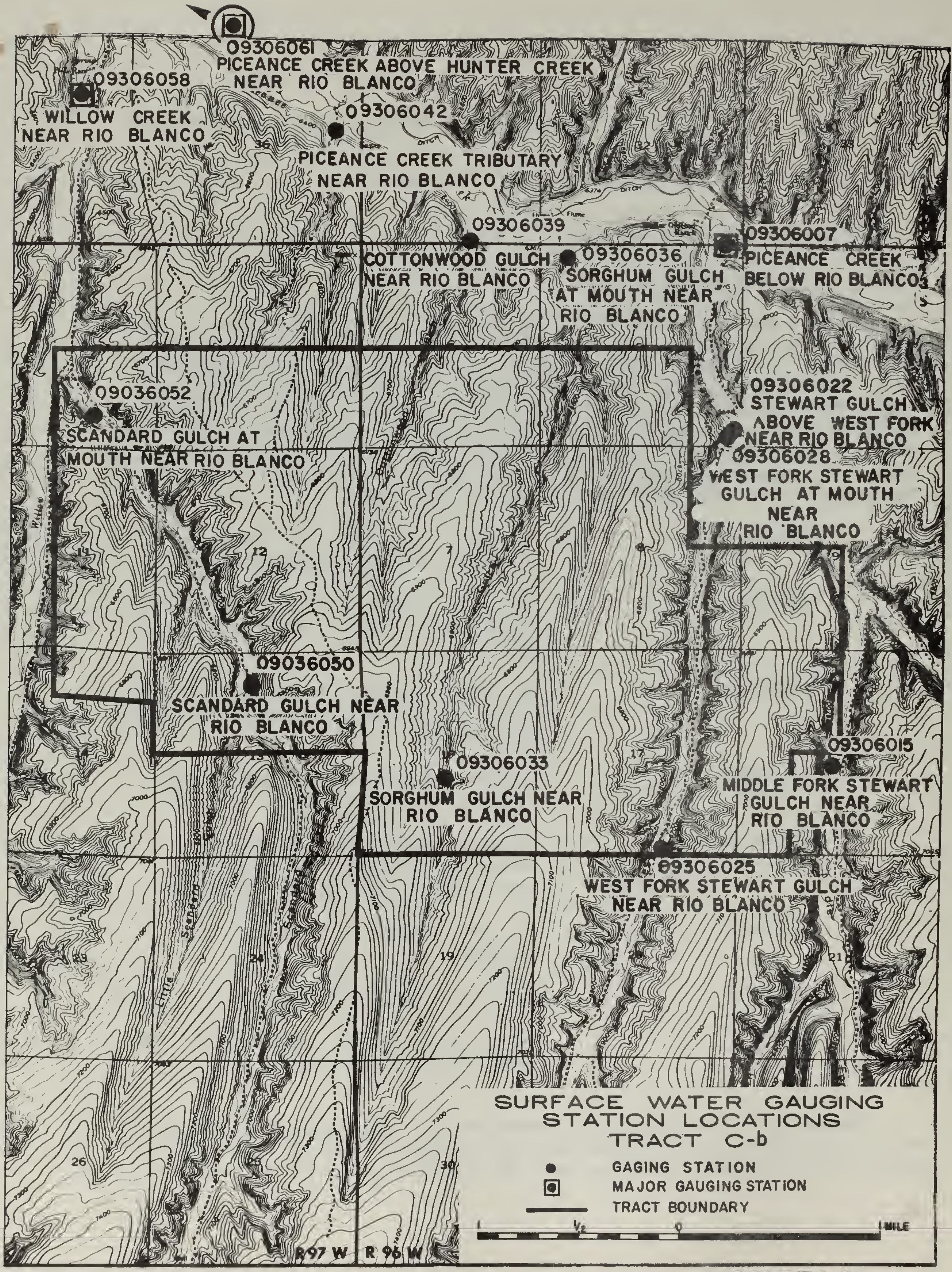

09306061
PICEANCE CREEK ABOVE HUNTER CREEK NEAR RIO BLANCO
09306058
WILLOW CREEK NEAR RIO BLANCO
09306042
PICEANCE CREEK TRIBUTARY NEAR RIO BLANCO
09306039
COTTONWOOD GULCH NEAR RIO BLANCO
09306036
SORGHUM GULCH AT MOUTH NEAR RIO BLANCO
09306007
PICEANCE CREEK BELOW RIO BLANCO
09036052
SCANDARD GULCH AT MOUTH NEAR RIO BLANCO
09306022
STEWART GULCH ABOVE WEST FORK NEAR RIO BLANCO
09306028
WEST FORK STEWART GULCH AT MOUTH NEAR RIO BLANCO
09036050
SCANDARD GULCH NEAR RIO BLANCO
09306033
SORGHUM GULCH NEAR RIO BLANCO
09306015
MIDDLE FORK STEWART GULCH NEAR RIO BLANCO
09306025
WEST FORK STEWART GULCH NEAR RIO BLANCO
SURFACE WATER GAUGING STATION LOCATIONS TRACT C-b
GAGING STATION
MAJOR GAUGING STATION
TRACT BOUNDARY
1
½
0
1 MILE
R97 W
R 96 W

FIGURE II A-1

TABLE II A-1

SURFACE WATER DATA PRESENTED QUARTERLY REPORT #8

Station	Daily Gauge Height	Daily Mean Sediment & Discharged Data	Dissolved Oxygen	pH Readings	Specific Conductance	Temperature	Turbidity Valves	Sediment Concentrations	Specific Conductance From PS-69 Samples	Temp, pH, D.O. & Conductivity PS-69 Samples	Water Quality Data Process Date 9-2-76
09306007*	x							x			x
09306015	x							x			x
09306022*	x							x			x
09306025	x							x			x
09306028	x							x			
09306033	x							x			x
09306036	x										
09306039	x				x	x					
09306042	x										
09306050	x										
09306052	x										
09306058*	x							x			x
09306061*	x							x			x

*major gauging station.

Table II A-2

SURFACE WATER QUALITY
BASELINE DATA

STATION: U. S. G. S. No. 09306007 Piceance Creek Below Rio Blanco Co.

		1974 - 1975			1976 Water Year									
	n	mean	min	max	10/8	10/31	11/17	12/16	1/6	2/26	3/16	4/12	5/11	5/24
1. Ammonia (mg/l) (Nitrogen)	20	.04	.00	.13	.02	.02	.02	.13	.09	.03	.03	.00	.01	
2. Arsenic (ug/l)	42	2	0	5	2	2	2	2	34*	2	-	-	3	
3. Barium (ug/l)	41	<87	0	200	100	200	300*	100			200			100
4. Bicarbonate (mg/l)	44	528	390	617	503	552	500	505	402	477	458	409	445	
5. Boron (ug/l)	41	218	110	330	230	200	210	200	180	190	210	130	140	140
6. Cadmium (ug/l)	40	<1	0	<15	0	0	-	1			1			
7. Calcium (mg/l)	45	69	51	79	64	73	63	64	69	70	67	63	65	
8. Carbonate (mg/l)	33	1.3	0	32	0	0	0	0	7	0	0	0	0	
9. Chloride (mg/l)	45	15	9	24	15	16	13	13	13	14	13	10	13	
10. Chromium (ug/l)	19	<6	0	90	0	0	-	0			<14			<20
11. Color (PCU)					13	10	8	1	2	5	4	30	5	
12. Copper (ug/l)	40	3	0	12	2	1	-	0			2			
13. Cyanide (mg/l)	20	.00	.00	.02	.0	.0	-	.0			.00			
14. Fluoride (mg/l)	45	1.0	.2	1.3	.8	.8	1.0	1.1	1.1	1.0	1.0	.6	.9	
15. Iron (ug/l)	45	70	0	390	50	70	20	10	10	30	10	-	20	50
16. Kjeldahl Nitrogen (mg/l)	20	.87	.25	4.0	-	-	.45	.29	.40	.39	1.1	.46	.38	
17. Lead (ug/l)	40	<3	0	<16	3	2	-	3			<14			<20
18. Lithium (ug/l)	40	7	0	20	10	5	20	10			20			20
19. Magnesium (mg/l)	45	47	34	57	47	45	43	44	110*	110	110	85	41	
20. Manganese (ug/l)	44	105	10	230				60			50			<150
21. Mercury (ug/l)	40	<.1	.0	.8	.0	.0	-	.1			.0			
22. Nitrate (mg/l) as NO_3	20	1.4	.22	3.7										
23. Nitrite (mg/l) as NO_2	20	.03	.00	.13										
24. Odor	25	0	0	0										
25. Oil & Grease (mg/l)	19	2.7	0	10	0	0	-	0			1			
26. Ortho-Phosphorus (mg/l) (P)	20	.04	.01	.11	.0*	.02	.01	.03	.02	.01	.01	.01	.01	
27. Potassium (mg/l)	45	3.7	2.4	19	3.3	3.7	2.6	2.3*	2.5	3.0	2.8	3.0	2.6	
28. Selenium (ug/l)	42	1	0	2	1	-	-	1						
29. Silica (mg/l)	45	15	3.4	18	16	16	15	16	14	14	14	13	16	
30. Sodium (mg/l)	45	125	75	160	130	130	120	120	110	110	110	85	110	
31. Solids, Dissolved (mg/l)	44	706	502	829	705	728	668	663	614	644	628	552	610	
32. Sulfate (mg/l)	45	160	110	200	180	170	160	150	150	150	150	140	140	
33. Sulfide (mg/l)	20	.2	.0	.9	.2	.0	-	.0			.0			
34. Turbidity (JTU)	20	54.9	0	480										
35. Zinc (ug/l)	40	19	0	60	10	0	0	10			0			60
36. pH	44	8.1	6.9	9.0	8.4	8.2	8.4	8.7	8.5	8.2	8.2	8.4	8.5	

*New Extreme

Table II A-3

SURFACE WATER QUALITY
BASELINE DATA

STATION: U. S. G. S. No. 09306022 Stewart Gulch Ab West Fork Nr Rio Blanco Co.

	1974 - 1975				1976 Water Year									
	n	mean	min	max	10/7	10/31	11/17	12/16	1/13	2/26	3/16	4/12	5/11	6/23
1. Ammonia (mg/1) (Nitrogen)	20	.02	.00	.09	.03	.01	.0	.01	.03	.00	.03	.02	.05	.02
2. Arsenic (ug/1)	33	1.0	0	4	1	1	1	1	1	1	-	-	0	1
3. Barium (ug/1)	30	<75	0	<200	100	0		200			0	200	0	300*
4. Bicarbonate (mg/1)	30	505	427	782	479	520	518	466	487	453	433	467	468	480
5. Boron (ug/1)	30	103	30	530	90	200	80	90	80	80	180	80	110	310
6. Cadmium (ug/1)	30	<1	0	3	0	0	-	1			1			0
7. Calcium (mg/1)	30	93	73	99	95	91	98	97	96	94	92	91	95	95
8. Carbonate (mg/1)	20	2	0	38	0	0	0	0	0	0	0	0	0	0
9. Chloride (mg/1)	30	7.5	6	16	7.2	6.5	6.8	5.8*	6,8	6.7	6.2	7.4	7.2	6.3
10. Chromium (ug/1)	20	<4	0	20	0	4	-	0			10			0
11. Color (PCU)					5	2	2	1	1	1	2	2	0	3
12. Copper (ug/1)	30	2.0	0	8	1	1	-	5			1			1
13. Cyanide (mg/1)	20	.0	.00	.02	.0	.0	-	.0			.00	.00	.00	.00
14. Fluoride (mg/1)	30	.4	.1	3.3	.2	.2	.3	.2	.3	.3	.2	.2	.3	.2
15. Iron (ug/1)	30	87	0	1200	30	40	20	0	20	20	-	-	20	10
16. Kjeldahl Nitrogen (mg/1)	20	.53	.14	3.5	-	-	.08	.02*	.23	.40	.46	.04	-	.40
17. Lead (ug/1)	30	3	0	7	2	0	-	2			8			0
18. Lithium (ug/1)	30	8	0	40	10	5	-	0			10			10
19. Magnesium (mg/1)	30	76	64	95	77	76	74	72	77	74	75	76	79	78
20. Manganese (ug/1)	30	10	0	57	-	-	-	20			<20			
21. Mercury (ug/1)	30	<.1	.0	.4	.0	.0	-	.2			.0			.0
22. Nitrate (mg/1) as NO_3	20	6.7	.22	8.4										
23. Nitrite (mg/1) as NO_2	20	.02	.00	.13										
24. Odor	30	0	0	0										
25. Oil & Grease (mg/1)	20	3	0	9	0	0	-	0			0	0	0	0
26. Ortho-Phosphorus (mg/1) (P)	20	.03	.01	.18	.0*	.02	.02	.02	.00	.01	.00	.01	.01	.02
27. Potassium (mg/1)	30	1.7	1.1	2.5	1.3	1.5	1.3	1.4	1.4	1.4	1.4	1.5	1.2	1.2
28. Selenium (ug/1)	30	1	0	2	1	2	-	1			1			1
29. Silica (mg/1)	30	15	11	17	15	14	14	15	14	15	15	14	15	16
30. Sodium (mg/1)	30	128	120	250	130	120	120	120	120	120	120	120	130	130
31. Solids, Dissolved (mg/1)	30	951	865	1160	968	892	949	921	926	914	873	907	924	954
32. Sulfate (mg/1)	30	370	330	490	400	320*	370	370	360	370	340	360	360	360
33. Sulfide (mg/1)	20	.13	.0	.7	.5	.0	-	.0			.0	10	.0	.0
34. Turbidity (JTU)	20	11	0	30										
35. Zinc (ug/1)	30	31.0	0	370	10	0	0	0			0			20
36. pH	30	8.2	7.2	8.8	7.9	8.0	8.2	8.6	8.5	8.2	8.3	8.3	8.3	8.4

*New Extreme

Table II A-4

SURFACE WATER QUALITY
BASELINE DATA

STATION: U. S. G. S. No. 09306025, West Fork Stewart Gulch Near Rio Blanco Co.

	1974 - 1975				1976 Water Year									
	n	mean	min	max	10/7	11/17	2/10	2/12	5/11	6/23				
1. Ammonia (mg/1) (Nitrogen)	9	.01	.00	.03	.13*	.00	.05	-	.11	.03				
2. Arsenic (ug/1)	29	1.	0	3	0	1	1	0	3	1				
3. Barium (ug/1)	28	<.56	0	220	100					300*				
4. Bicarbonate (mg/1)	30	524	438	757	508	378*	69*	151	593	573				
5. Boron (ug/1)	28	107	40	160	90	70	100	100	120	110				
6. Cadmium (ug/1)	28	1	0	2	1					3*				
7. Calcium (mg/1)	30	90	48	130	84	57	17*	28	94	98				
8. Carbonate (mg/1)	21	1	0	13	0	0	0	0	0	37				
9. Chloride (mg/1)	30	10.4	6.5	29.0	11	6.8	2.0*	5.7	14	9				
10. Chromium (ug/1)	9	3	0	20	0					0				
11. Color (PCU)					10	12	45	130	30	35				
12. Copper (ug/1)	28	3	0	8	1					7				
13. Cyanide (mg/1)	9	.00	.00	.01	.00					.00				
14. Fluoride (mg/1)	30	.2	.0	1.2	.2	.2	.1	.1	.3	.2				
15. Iron (ug/1)	30	57	0	220	100	100	210	230*	50	90				
16. Kjeldahl Nitrogen (mg/1)	9	.50	.12	1.3	-	.44	1.4	2.0*	.82	.51				
17. Lead (ug/1)	28	3	0	<20	2					6				
18. Lithium (ug/1)	28	5	0	20	10					10				
19. Magnesium (mg/1)	30	96	74	120	98	67*	3.1*	16	98	99				
20. Manganese (ug/1)	30	5	0	20										
21. Mercury (ug/1)	29	.1	.0	.9	.0					.0				
22. Nitrate (mg/1) as NO_3	9	.80	.00	5.7										
23. Nitrite (mg/1) as NO_2	9	.02	.00	.03										
24. Odor	15	0	0	2										
25. Oil & Grease (mg/1)	9	1	0	2										
26. Ortho-Phosphorus (mg/1) (P)	9	.01	.00	.04	.00	.00	.14	.26*	.00	.00				
27. Potassium (mg/1)	30	3.1	.9	9.8	3	3.9	4.6	12*	4.8	2.1				
28. Selenium (ug/1)	29	.5	0	5	0					0				
29. Silica (mg/1)	30	13.6	2.8	18	12	8.8	2.5*	5.4	9.4	14				
30. Sodium (mg/1)	30	158	130	220	150	110*	3.5*	24	170	160				
31. Solids, Dissolved (mg/1)	30	1086	943	1450	1120	782*	74*	239	1130	1180				
32. Sulfate (mg/1)	30	490	380	590	510	340*	4.4*	70	450	470				
33. Sulfide (mg/1)	9	.1	.0	.2	.3					.0				
34. Turbidity (JTU)	9	8	1	16										
35. Zinc (ug/1)	28	15	0	40	10					20				
36. pH	28	8.3	7.4	8.9	8.5	-	8.3	8.8	8.6	8.8				

*New Extreme

Table II A-5

SURFACE WATER QUALITY
BASELINE DATA

STATION: U. S. G. S. No. 09306058 Willow Creek Near Rio Blanco Co.

		1974 - 1975			1976 Water Year									
	n	mean	min	max	10/8	11/3	12/17	1/21	2/25	3/17	4/13	5/12	6/24	
1. Ammonia (mg/1) (Nitrogen)	11	.02	.00	.11	.02	.01	.01	.04	.00	.03	.02	.03		
2. Arsenic (ug/1)	24	1.3	0	4	1	1	1	1	0	-	0	0		
3. Barium (ug/1)	26	<55	0	200	0	100	200	100	200	0			70	
4. Bicarbonate (mg/1)	28	492	444	570	486	502	497	468	426	443	315	477		
5. Boron (ug/1)	26	118	70	140	120	100	110	90	100	140	830	2800*	80	
6. Cadmium (ug/1)	26	<1	0	6	1	0	1	0	1	1				
7. Calcium (mg/1)	28	92	64	100	94	92	94	94	100	95	86	83		
8. Carbonate (mg/1)	24	2	0	46	0	0	0	0	26	0	10	0		
9. Chloride (mg/1)	28	11.3	9.8	14	13	8.2*	8.8	29*	11	9.2	9.8	9.8		
10. Chromium (ug/1)	13	<6	0	40	0	0	0			0			<20	
11. Color (PCU)	11	5	3	9	5	3	2	3	2	2	0*	0*		
12. Copper (ug/1)	26	<3	0	17	2	1	1			2				
13. Cyanide (mg/1)	11	.00	.00	.01	.00	.00	.00	.00	.00	.00	.00	.00		
14. Fluoride (mg/1)	28	.4	.3	1.3	.4	.4	.5	.4	.4	.3				
15. Iron (ug/1)	29	33	10	150	40	30	10	10	10	-	10	10	40	
16. Kjeldahl Nitrogen (mg/1)	11	.82	.12	3.5	-	-	.76	.21	.20	.31	.22	.67		
17. Lead (ug/1)	26	<3.4	0	<20	3	2	1			3			<20	
18. Lithium (ug/1)	26	6	0	10	10	5	0			10			20*	
19. Magnesium (mg/1)	28	78	68	87	74	72	71	67*	69	69	71	79		
20. Manganese (ug/1)	29	13	0	50			<20			20			20	
21. Mercury (ug/1)	15	<.1	.0	.2	.0	.0	.0			1.0*				
22. Nitrate (mg/1) as NO_3	11	1.3	.62	2.1										
23. Nitrite (mg/1) as NO_2	11	.02	.00	.03										
24. Odor	29	0	0	0										
25. Oil & Grease (mg/1)	11	2	0	3	0	0	0	0	0	0				
26. Ortho-Phosphorus (mg/1) (P)	11	.02	.01	.10	.00*	.01	.17*	.00	.01	.00	.00	.00		
27. Potassium (mg/1)	28	2.3	1.1	5.0	3.2	2.4	1.7	1.4	1.7	1.7	1.4	1.7		
28. Selenium (ug/1)	27	1	0	2	1	0	1			1				
29. Silica (mg/1)	28	16	12	18	15	14	15	14	16	15	16	15		
30. Sodium (mg/1)	28	130	110	180	120	110	120	110	110	110	120	130		
31. Solids, Dissolved (mg/1)	28	952	860	1150	901	868	910	862	870	814	782*	887*		
32. Sulfate (mg/1)	28	366	310	500	340	320	350	310	320	290*	310	330		
33. Sulfide (mg/1)	11	.1	.0	.2	.3	.0	-	.0	-	.0				
34. Turbidity (JTU)														
35. Zinc (ug/1)	26	14	0	40	10	4	0			0		0		
36. pH	27	8.2	7.8	9.4	8.5	8.7	8.9	8.4	8.4	8.5	8.4	8.5		

*New Extreme

Table II A-6

SURFACE WATER QUALITY
BASELINE DATA

STATION: U. S. G. S. No. 09306061, Piceance Creek above Hunter Creek Near Rio Blanco Co.

	1974 - 1975				1976 Water Year								
	n	mean	min	max	10/8	11/3	12/18	1/12	2/25	3/17	4/13	5/12	6/25
1. Ammonia (mg/1) (Nitrogen)	19	.03	.00	.09	.02	.04	.02	.03	.04	.04	.05	.03	
2. Arsenic (ug/1)	40	2	0	6	3	1	2	2	1	-	1	1	
3. Barium (ug/1)	41	<70	0	<200	0	100	200*			200			80
4. Bicarbonate (mg/1)	42	582	443	690	602	546	537	495	309*	471	313	577	
5. Boron (ug/1)	41	200	120	320	200	200	160	140	140	200	390	470*	140
6. Cadmium (ug/1)	41	<1	0	6	0	1	0			1			
7. Calcium (mg/1)	42	77	59	88	84	85	82	80	85	80	65	76	
8. Carbonate (mg/1)	31	2	0	39	0	0	0	0	85*	0	0	0	
9. Chloride (mg/1)	42	13	11	16	15	13	11	13	13	11	14	14	
10. Chromium (ug/1)	21	<4	0	40	0	0	0			0			<20
11. Color (PCU)	17	9	0	30	5	10	4	3	7	5	40*	5	
12. Copper (ug/1)	41	<4	0	20	2	2	1			2			
13. Cyanide (mg/1)	19	.00	.00	.03	.00	.00	.00			.00			
14. Fluoride (mg/1)	42	.7	.3	1.5	.5	.8	.7	.6	.6	.6	.6	.7	
15. Iron (ug/1)	44	<65	<2	880	20	20	.0*	20	20	-	60	510	40
16. Kjeldahl Nitrogen (mg/1)	19	1.12	.21	4.0	-	-	.24	.31	.48	.42	.28	.37	
17. Lead (ug/1)	41	<3	0	20	2	0	1			2			<20
18. Lithium (ug/1)	41	9	0	20	10	10	10			0			20
19. Magnesium (mg/1)	42	68	46	88	83	56	64	62	63	61	44	73	
20. Manganese (ug/1)	44	65	0	150	-	-	40			30			120
21. Mercury (ug/1)	40	.03	.0	<.1	.0	.0	.1*			.0			
22. Nitrate (mg/1) as NO_3	19	2.3	.35	3.5									
23. Nitrite (mg/1) as NO_2	19	.02	.00	.03									
24. Odor	0	0	0	0									
25. Oil & Grease (mg/1)	19	4	0	9	0	0	0			1			
26. Ortho-Phosphorus (mg/1) (P)	42	.03	.00	.08	.01	.03	.04	.01	.02	.00	.02	.00	
27. Potassium (mg/1)	42	3.7	1.2	6.4	3.4	3.9	2.5	2.4	3.0	2.8	2.5	3.4	
28. Selenium (ug/1)	40	1	0	2	1	1	1			1	13	15	
29. Silica (mg/1)	42	17	12	20	16	16	16	15	15	15	97*	170	
30. Sodium (mg/1)	42	152	100	200	160	120	140	120	120	120	584	928	
31. Solids, Dissolved (mg/1)	42	913	639	1090	1010	817	867	823	835	798	190	290	
32. Sulfate (mg/1)	42	290	170	380	350	250	280	280	290	270			
33. Sulfide (mg/1)	19	.2	.0	.5	.2	.0	.0			.0			
34. Turbidity (JTU)	19	100	3	670									
35. Zinc (ug/1)	41	<15	0	50	10	6	10			0		0	
36. pH	41	8.2	7.5	9.2	7.7	8.6	8.7	8.5	-	8.3	8.3	8.5	

White River are included in Quarterly Data Report #8, as well as precipitation gauge data for 1975 and 1976 through September beginning on Page II A-125 and a brief discussion on streambed sediments presented on Page II A-317 in the data report.

Table II A-7 presents the chemical analysis of precipitation collected at two sites, SG-18A and Cb-2, within the study area. Data are fairly consistent through time and across the Tract.

Streambed Sediments

Sampling Procedure

Samples of streambed sediments were obtained from each of the major drainages. Where possible, the material was collected from deposits which were obviously the result of recent deposition. This was feasible in the case of West Fork Stewart, Sorghum, and Cottonwood Creeks, where recent storms had caused runoff which resulted in new deposits near the mouth of these tributaries. In every case an attempt was made to collect the finest material visible and a composite sample was assembled from the surface layers of all easily located deposits.

In the case of Scandard Gulch and an unnamed gulch west of Cottonwood, (at alluvial well A-5 and water gauging station 042) no flow has occurred during the baseline data-gathering period. Any fine sediments deposited as a result of flow in previous years have probably been removed by wind erosion. As a result, these samples were collected at random from the streambed (again attempting to collect the finest material available) over a distance of about 300 yards from the gauging stations. Surface material was not used in order to minimize the influence of recent aeolian deposits, if any.

For the flowing streams, Willow Creek at mouth and Piceance Creek below Cottonwood, samples were collected from the stream bottom in such a way as to be comparable to the Cottonwood, Sorghum, and West Stewart samples. That is, only recently deposited sediments were used (as determined by differentiation of color and compaction and relationships to vegetation in shallow back-water areas). Samples were air dried where necessary, then passed through a 1/16" mesh sieve to remove any rocks and trash before blending and separating into fractions for analysis. A portion of each sample will be maintained for future reference.

To date, only the Sorghum Gulch sample has been analyzed. Included in Quarterly Data Report #8 are particle size and elemental analysis as performed by Agricultural Consultants Laboratory and a quantitative x-ray diffraction analysis performed by the Colorado School of Mines Research Institute.

It was of interest to compare the elemental analysis for sediment against that for air-blown particulates. When averaged over a wide area, one might expect a correlation between dust and sediment. Results of

Table II A-7

CHEMICAL ANALYSIS OF
PRECIPITATION - C-b TRACT
(mg/1)

	SG-18A			Cb-2			*
	snow	June	July	snow	June	July	
Sodium	0.8	0.3	0.1	0.3	0.3	0.2	.42
Potassium	0.1	0.2	0.1	0.2	0.2	0.2	
Calcium	1.0	1.6	1.1	1.0	1.7	1.3	1.41
Magnesium	0.4	0.3	0.3	0.4	0.3	0.2	
Lithium	<.5	<.5	<.5	<.5	<.5	<.5	
Strontium	<.1	<.1	<.1	<.1	<.1	<.1	
Iron	<.1	<.1	<.1	0.2	<.1	<.1	
Manganese	<.1	<.1	<.1	<.1	<.1	<.1	
Arsenic	.003	0.5	<.5	≤.002	0.5	0.5	
Mercury	<.03	<.03	<.03	0.001	0.03	<.03	
Sulfate	<4	<4	<4	<4	<4	<4	2.14
Carbonate	<1	ND	ND	<1	ND	ND	
Bicarbonate	<5	9	8	<5	9	9	
Chloride	<1	<1	<1	1.2	<1	<1	.22
Fluoride	<.1	<.1	<.1	<.1	<.1	<.1	
Boron	<.1	ND	ND	<.1	ND	ND	
pH	6.7	6.6	6.7	6.6	6.8	6.7	
TDS	2.3	7	6	2.1	7	6	
Kjeldahl N	1.3	1.5	0.8	1.8	1.2	1.2	

ND = Not detected

* Average for inland sampling stations in United States for 1 year.
Data from Junge & Werby (1958) as reported by Whitehead & Feth (1964).

quarterly air sampling for particulates, however, have shown widely fluctuating results and no correlation with the Sorghum Gulch sediment can be seen (Table II A-8).

II A-2 Springs and Seeps

Water quality analyses are reported for nine springs, two special stream samples, and rain samples taken at the location for Cb-2 and SG-18A. These data are for samples obtained in June and July according to the 1976 Ground Water Sampling Program (see Quarterly Summary Report #6, p. 15).

II A-3 Ground Water

Ground Water Quality

Analyses of water quality from nine alluvial wells and the upper and lower aquifer wells were completed in time for presentation in the data report. These data are for water samples taken in February per the 1976 Ground Water Sampling Program (see Quarterly Summary Report #6, p. 15). The analyses for the springs and samples of rain are reported in this section in Quarterly Data Report #8 and in the section on springs and seeps in the data report.

Water level data from the continuous recording instruments at AT-1, Cb-1, Cb-2, Cb-4, SG-6, SG-8, SG-10, SG-17, A-1, A-2, A-7, and A-8 are presented beginning on Page II A-257 of the data report.

The following is a brief description of a model study concerning the hydraulic conductivity of the Mahogany mining zone which is presented in Quarterly Data Report #8. The study found the hydraulic conductivity to be substantially lower than values calculated by the type curve method.

Hydraulic Conductivity Modeling

Summary

The hydraulic conductivity of the Mahogany mining zone in the vertical direction is found to be substantially lower than the value calculated by "type curve" methods. This emphasizes the reliability of the conclusion that the Mahogany zone hydraulically separates the upper and lower aquifers within Tract C-b.

Aquitards play an important role in the hydrology of multiple aquifer systems. The problems are commonly simplified by assuming that vertical components of flow within the aquifers and horizontal components of flow within the aquitards are negligible. These assumptions are generally valid since the contrast in hydraulic conductivity between the aquifers and aquitards is usually large.

Table II A-8

CHEMICAL ANALYSIS OF STREAM SEDIMENTS
AVERAGE AIR PARTICULATES
TRACT C-b

Element	Sediment Analysis p.p.m.	Average Air Particulates* p.p.m.
Arsenic	-.1	46
Barium	260	164
Boron	26	530
Cadmium	-.1	3.8
Chloride	21	441
Chromium	2.4	38
Cobalt	-1	7.8
Copper	11	585
Fluoride	2	3580
Lead	-.1	187
Manganese	410	880
Mercury	-.01	not reported
Molybdenum	-.1	7.2
Nickel	200	10
Phosphate	620	4600
Selenium	-.01	2.3
Sulfur	32	2030
Vanadium	16	185
Zinc	43	not reported

Minus sign indicates less than reporting minimums.

*Averages from Radian quarterly composite filter samples.

The C-b Tract hydrology poses a unique challenge to mine inflow analysis. The Mahogany mining zone is generally believed to separate hydraulically the upper and lower aquifer systems of the Tract by virtue of its low vertical leakance. However, under a large differential pressure across this zone, the leakage might be substantial. An accurate estimate of leakance, or the response in the lower aquifer due to excitation of the upper aquifer could give a better definition of this problem.

Method

The leakance of the Mahogany zone was estimated in a previous report using the type curves of Professor R. E. Glover. These type curves, unfortunately, may lead to significant errors owing to the assumptions employed in developing these curves. A more rational and complete analytic solution has been developed by S. P. Newman and P. A. Witherspoon (1969) for this problem. Their solution differs from that of Professor Glover in that the effects of storage in the aquitard and drawdown in the unpumped aquifer are both considered. According to their solution, the drawdown in the unpumped aquifer (Figure II A-2) is given by:

$$S_2(r,t)=\frac{Q_1}{4\pi T_1}\int_0^\infty \left[1-\exp(-y^2\lambda_{D1})\right]\frac{2(r/B_{21})^2}{F(y)}\left\{Jo\left[W_1(y)\right]-Jo\left[W_2(y)\right]\right\}\frac{dy}{\sin y} \text{ ----------------- } (1)$$

Where

$$\lambda_{D1}=t_{D1}(r/B_{11})^4/(4\beta_{11})^2 \text{ --- } (2)$$

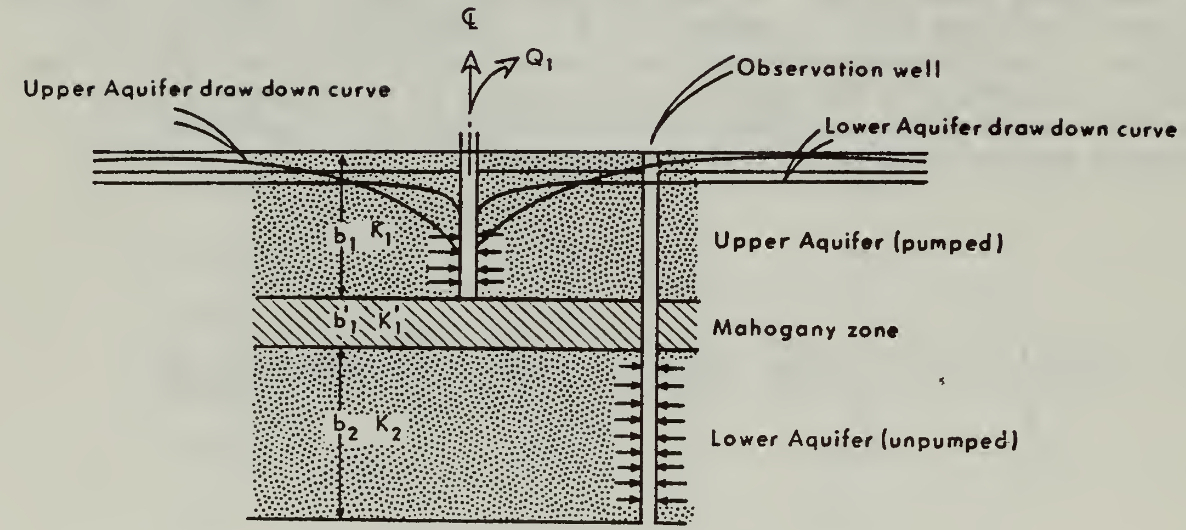
$$W_1^2(y)=\tfrac{1}{2}\left[N(y)+F(y)\right] \text{ --- } (3)$$

$$W_2^2(y)=\tfrac{1}{2}\left[N(y)-F(y)\right] \text{ --- } (4)$$

$$F^2(y)=M^2(y)+\left[\frac{2(r/B_{11})(r/B_{21})y}{\sin y}\right]^2 \text{ ------------------------------ } (5)$$

$$M(y)=\left[\frac{(r/B_{11})^4}{(4\beta_{11})^2}-\frac{(r/B_{21})^4}{(4\beta_{21})^2}\right]y^2-\left[(r/B_{11})^2-(r/B_{21})^2\right]y\cot y \text{ --------- } (6)$$

Figure II A-2
C-B TRACT AQUIFER SYSTEM



And

$$N(y)=\left[\frac{(r/B_{11})^4}{(4\beta_{11})^2}+\frac{(r/B_{21})^4}{(4\beta_{21})^2}\right]y^2-\left[(r/B_{11})^2+(r/B_{21})^2\right]y\cot y \text{ -------- } (7)$$

Newman and Witherspoon have evaluated equation (1) using the Zonneveld adaption of the Adams-Moulton numeric method of integration. This method is considered inefficient. An alternate algorithm used in this analysis is outlined below.

If y_n be the value of y corresponding to the nth zero of $Jo\left[W(y)\right]$

and let S_N be the partial sum:

$$S_N=\frac{Q_1}{4\pi T_1}\sum_{n=1}^{N}\int_{y_{n-1}}^{y_n}\left[1-\exp(-y^2\lambda_{D_1})\right]\frac{2(r/B_{21})^2}{F(y)}\left\{Jo\left[W_1(y)\right]-Jo\left[W_2(y)\right]\right\}\frac{dy}{\sin y} \text{ ---- } (8)$$

and

$$\lim_{N\to\infty} S_N=s_2 \text{ where } s_2 \text{ is defined in (1).}$$

The integrals in (8) are easily evaluated by Simpson's rule. The value of y corresponding to nth zero of $Jo\left[W(y)\right]$ is calculated by Newton-Raphson interative method.

A special computer program is developed to evaluate this integral with double precision.

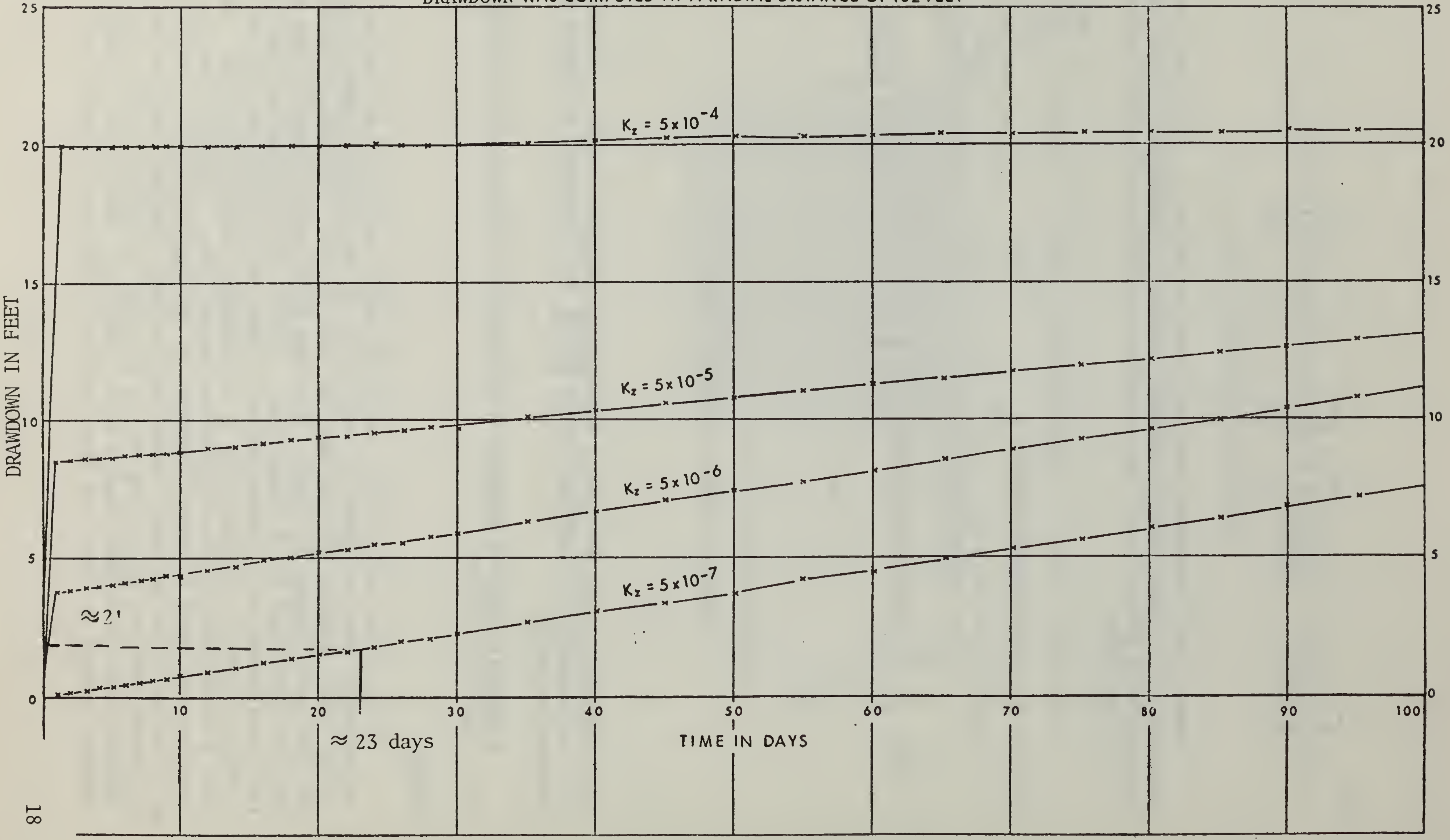
Result

During upper aquifer test, when the entire saturated section above the Mahogany zone was pumped at well AT-1, no measurable drawdown was noted in the lower aquifer 102 feet away at well AT 1-c. Pumping was maintained for 550 hours (almost 23 days). The same might not be noted if the pumping had been continued for a longer time. Hence, the drawdown has been analytically evaluated for a longer period of time and for different values of vertical hydraulic conductivity of the Mahogany zone and plotted. Figure II A-3 shows these plots of drawdowns versus time. Assuming that the pressure bomb used to record drawdown in the pumping test was sensitive for pressure fluctuations of about half a foot, the plots may be interpreted to reveal that the true value of the vertical hydraulic conductivity of the Mahogany zone is no more than 5×10^{-7} feet/day. That is at 23 days. The drawdown should be about two feet based on a hydraulic conductivity of

Figure II A-3

DRAWDOWN IN LOWER AQUIFER DUE TO PUMPING OF UPPER AQUIFER FOR DIFFERENT VALUES OF CONDUCTIVITY OF MAHOGANY ZONE

K_z = VERTICAL HYDRAULIC CONDUCTIVITY OF MAHOGANY ZONE IN FEET/DAY
PUMPING RATE IN THE UPPER AQUIFER = 373 GPM
DRAWDOWN WAS COMPUTED AT A RADIAL DISTANCE OF 102 FEET



$K_z = 5 \times 10^{-7}$. Since no drawdown was measured, within an accuracy of one-half foot, it can be said that the hydraulic conductivity of the Mahogany zone is less than 5×10^{-7}. Thus the contribution of vertical flow to mine discharge over an area of 10 square miles can be shown to be negligible compared to the total mine discharge.

The computer outputs and a listing of the program are presented in full in Quarterly Data Report #8.

Conclusion

The aquitards will effectively impede the vertical flow of water. Horizontal flow is the major contributor to the mine discharge.

Notation

b_i	Thickness of i^{th} aquifer (L)
b_j	Thickness of j^{th} aquitard (L)
$Jo(.)$	Zero order Bessel function of first kind
K_i	Hydraulic conductivity of i^{th} aquifer (L/T)
K_j	Hydraulic conductivity of j^{th} aquitard (L/T)
Q_i	Pumping rate from i^{th} aquifer (L^3/T)
r	Radial distance from pumping well (L)
r/B_{ij}	$r\sqrt{K_j/K_i b_i b_j}$
S_{s_i}	Specific storage of i^{th} aquifer (L^{-1})
S_{s_j}	Specific storage of j^{th} aquitard (L^{-1})
s_i	Drawdown in i^{th} aquifer (L)
T_i	Transmissivity of i^{th} aquifer (L^2/T)
t	Pumping time (T)
t_{Di}	Dimensionless time for pumped (i^{th}) aquifer ($K_i t/S_{s_i} r^2$)
y	Dummy variable a function of r & t
β_{ij}	$r/4b_i\sqrt{K_j S_{s_j}/K_i S_{s_i}}$

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Newman, S. P. and Witherspoon, P. A., 1969, Theory of Flow in a Confined Two Aquifer System, Water Resources Research, V. 5, No. 4, pp. 803-816.

Whitehead, H. C. and Feth, J. H. 1964, Chemical Composition of Rain, Dry Fallout, and Bulk Precipitation at Menlo Park, California, 1957-59: Jour. Geophys, Research, V.69, pp. 3319-3333.

II B AIR QUALITY

The current air quality/meteorology network is shown on Figure II B-1, and includes five air-quality trailers, the meteorological tower, two acoustic sounders, three ground-level mechanical weather stations, and an area-wide visibility site. Stations 020, 021, and 022 are located in the Piceance Creek Valley at Redd Ranch, Rock School, and the Gerald Oldland Ranch, respectively. Stations 023 and 024 are located on the Tract plateau. Locations of sounders and mechanical weather stations have been moved and are discussed later. The visibility site is located off-Tract in the southwest quarter of the southwest quarter of Section 19 (T3S, R97W) along the Hunter Creek Road near Dry Gulch. The reader is referred to Tables II C-1 and II C-2 of Quarterly Data Report #5 for specific data measurements and sampling frequencies.

The air quality discussion is divided into paragraphs as follows: Air Quality and Surface Meteorology, Low Altitude Meteorology, Upper Air Studies, Visibility, Noise, and Atmospheric Diffusion Studies.

II B-1 Air Quality and Surface Meteorology

Tables II B-1 through II B-5 summarize the maximum concentrations for the gases and particulates from March 1976 through May 1976. These concentrations, listed for 5-minute, 1-hour, 3-hour, 8-hour, and 24-hour maxima, correspond to the averaging time intervals determined by State and Federal regulations. Table II B-6 presents the frequency distribution by concentration per station for particulates and shows the geometric mean for the three months. On Tables II B-7 through II B-15 are tabulated the monthly maximum sliding one-hour averages. Hydrocarbon maxima are reported for the 6:00-9:00 a.m. period and particulate maxima are reported for a 24-hour period. These are shown with the corresponding data, wind direction, and speed. Monthly averages are found in Table II B-16.

The lower detectable limits for the air-quality instruments are stated to be 5 ppb with the exception of the ozone instrument which is given as 0.5 ppb. In practice the reliable lower detectable limit for the non-methane hydrocarbons is considerably above this; these represent some of the least reliable air quality data. The C-b Tract ambient air concentrations for all the gases except for ozone and methane, are frequently near or below the measuring instrument's minimum detectable limit. Inherent measurement inaccuracies in most air quality instruments, particularly at or near the lower detection limits, make much of the air quality data interpretation a matter of judgement and experience.

The May through July data for SO_2 show that the ambient concentrations were below detection limits (13 ug/m^3) for almost the entire period at all five stations. The maximum hourly reading occurred at Station 021 on May 16, and was 18.2 ug/m^3, which is only slightly over the detection limit. Neither the hourly maxima (Table II B-7)nor the monthly average (Table II B-16) for May, June, and July are significantly different from those of the previous six months.

(Text continued on Page 38)

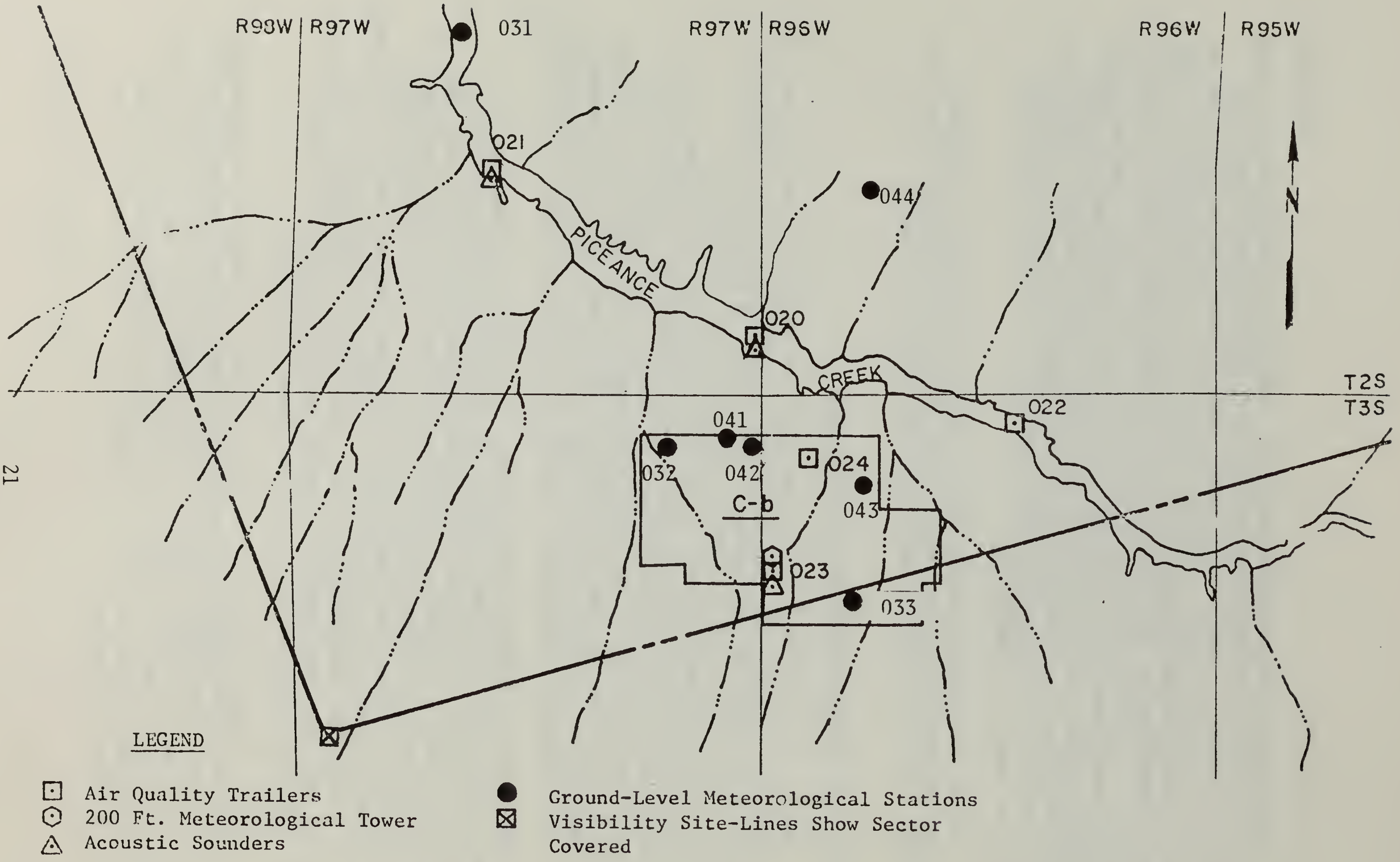


Figure II B-1 AIR QUALITY AND METEOROLOGICAL STATION LOCATIONS

Table II B-1 QUARTERLY SUMMARY (March '76 - May '76)

(Concentrations in micrograms per cubic meter)

TRAILER NO. 20

Recorded Parameter	Average	Maximum 24-hr. Concentration		Maximum 8-hr. Concentration		Maximum 3-hr. Concentration		Maximum 1-hr. Concentration		Maximum 5-min. Concentration	
		Value	Time	Value	Time*	Value	Time*	Value	Time*	Value	Time*
SO_2	.3	8.5	5/22 8:00					12.4	5/22 4:35	41.7	4/4 10:45
H_2S	.1							30.9	4/5 15:55	72.0	4/5 16:05
Particulates	10.5[1]	79.0	4/2								
Total Hydrocarbons	581.4					667.7	4/2 6:00			1851.4	4/5 15:35
CH_4	552.6					598.1	4/21 6:00			1508.2	5/25 10:30
Non-CH_4 Hydrocarbons	31.0					58.6	4/24 6:00				
O_3	59.9							134.6	5/25 10:25	140.7	4/9 17:00
NO_x	21.0							116.5	5/15 3:20	134.8	5/14 11:50
NO	12.3							78.6	5/25 22:55	84.3	5/25 23:45
CO	1291.5			1429.4	5/24 7:55			1688.8	5/20 15:55	4119.8	5/20 16:20
NO_2	7.9							116.5	5/15 3:20	134.8	5/14 11:50

1 - Geometric Mean.

*Start of interval of occurrence.

Table II B-2 **QUARTERLY SUMMARY** (March '76 - May '76)

(Concentrations in micrograms per cubic meter)

TRAILER NO. 21

Recorded Parameter	Average	Maximum 24-hr. Concentration		Maximum 8-hr. Concentration		Maximum 3-hr. Concentration		Maximum 1-hr. Concentration		Maximum 5-min. Concentration	
		Value	Time	Value	Time*	Value	Time*	Value	Time*	Value	Time*
SO_2	.8	11.3	5/15 14:00					23.4	3/13 12:10	49.5	4/24 9:20
H_2S [3]	.6							8.1	5/25 21:15	8.3	4/24 8:45
Particulates	10.0[1]	90.0	4/2								
Total Hydrocarbons											
CH_4											
Non-CH_4 Hydrocarbons											
O_3											
NO_x											
NO											
CO											

1 - Geometric Mean.

3 - April and May Data.

*Start of time interval of occurrence.

Table II B-3 QUARTERLY SUMMARY (MARCH 1976 - MAY 1976)

(Concentrations in micrograms per cubic meter)

TRAILER NO. 22

Recorded Parameter	Average	Maximum 24-hr. Concentration		Maximum 8-hr. Concentration		Maximum 3-hr. Concentration		Maximum 1-hr. Concentration		Maximum 5-min. Concentration	
		Value	Time	Value	Time*	Value	Time*	Value	Time*	Value	Time*
SO_2	1.0	7.7	3/24 9:00					17.4	3/14 0:10	26.0	3/14 0:20
H_2S	.2							7.1	4/22 10:50	12.5	5/10 10:45
Particulates	8.2 [1]	60.0	4/2								
Total Hydrocarbons											
CH_4											
Non-CH_4 Hydrocarbons											
O_3											
NO_x											
NO											
CO											

1 - Geometric Mean.

*Start of time interval of occurrence.

Table II B-4 **QUARTERLY SUMMARY** (MARCH 1976 - MAY 1976)

(Concentrations in micrograms per cubic meter)

TRAILER 23

Recorded Parameter	Average	Maximum 24-hr. Concentration		Maximum 8-hr. Concentration		Maximum 3-hr. Concentration		Maximum 1-hr. Concentration		Maximum 5-min. Concentration	
		Value	Time	Value	Time*	Value	Time*	Value	Time*	Value	Time*
SO_2 [3]	.5	9.4	5/18 10:00					13.9	5/18 10:05	80.8	5/18 10:10
H_2S	.4							7.1	4/26 13:50	19.4	5/25 11:30
Particulates	7.8[1]	96.0	4/2								
Total Hydro-carbons	1766.6					2949.5	4/29 6:00			3256.2	4/20 12:25
CH_4	1010.0					1170.4	3/14 6:00			2899.3	4/20 6:35
Non-CH_4 Hydrocarbons	756.6					1992.6	4/29 6:00			2227.2	4/21 12:05
O_3	64.6							123.6	4/26 14:05	127.0	4/26 14:15
NO_x	1.8							29.3	5/31 19:35	31.8	5/30 18:05
NO	1.3							23.2	4/20 20:15	30.0	3/4 5:55
CO	1039.0			1928.6	5/13 2:55			2011.5	5/13 8:10	5233.3	5/26 13:00
NO_2	.5							16.1	5/20 19:35	20.5	5/20 19:40

1 - Geometric Mean.

*Start of interval of occurrence.

3 - April and May Data.

Table II B-5 QUARTERLY SUMMARY (MARCH 1976 - MAY 1976)

(Concentrations in micrograms per cubic meter)

TRAILER NO. 24

Recorded Parameter	Average	Maximum 24-hr. Concentration		Maximum 8-hr. Concentration		Maximum 3-hr. Concentration		Maximum 1-hr. Concentration		Maximum 5-min. Concentration	
		Value	Time	Value	Time*	Value	Time*	Value	Time*	Value	Time*
SO_2	.4	2.9	5/19 11:00					4.6	3/14 4:30	18.2	4/17 12:55
H_2S	.0							7.7	4/12 14:45	33.2	5/12 9:10
Particulates	10.3[1]	116.0	4/2								
Total Hydrocarbons											
CH_4											
Non-CH_4 Hydrocarbons											
O_3											
NO_x											
NO											
CO											

1 - Geometric Mean.

*Start of time interval of occurrence.

Table II B- 6

PARTICULATE CONCENTRATION FREQUENCY DISTRIBUTION

C-b SHALE OIL MONITORING PROJECT

March 1976 - May 1976

SITE	020	021	022	023	024
Concentration ug/m^3					
>260					
240-260					
200-220					
180-200					
160-180					
140-160					
120-140					1
100-120				1	0
80-100		1		0	0
60-80	1	0	1	1	0
40-60	5	1	2	1	3
20-40	16	20	9	13	18
< 20	69	70	72	73	69
TOTAL (No. Samples)	91	92	84	89	91
Geometric Mean (ug/m^3)	10.5	10.0	8.2	9.8	10.3

Table II B-7

1- HOUR MAXIMUM CONCENTRATIONS

SO_2

Constituent

By Month

Trailer	Item	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.
020	Value (ug/m^3)	11.9	.2	0.0*	3.5	1.1	3.5	12.4	11.1	7.6			
	Date	11/15	12/12		2/17	3/14	4/4	5/22	6/11	7/13			
	Time (MST)	18:10	1:35		14:25	9:45	9:45	4:35	4:00	11:35			
	Wind Direction (Deg.)	113	99		296	175	173	102	123	279			
	Wind Speed (MPH)	4	3		10	8	8	(2)	(2)	(2)			
023	Value (ug/m^3)	2.0	19.1	51.4(1)	7.2(1)	23.4(1)	12.8	13.9	6.9	7.2			
	Date	11/18	12/13	1/5	2/6	3/13	4/28	5/18	6/3	7/18			
	Time (MST)	12:40	7:10	11:10	11:30	12:10	6:40	10:05	13:15	13:00			
	Wind Direction (Deg.)	241	139	129	311	128	271	221	194	315			
	Wind Speed (MPH)	12	5	14	3	7	1	13	22	14			
021	Value (ug/m^3)	11.7	5.2	28.2	10.4	54.6	18.2	18.2	12.8	14.3			
	Date	11/12	12/6	1/5	2/1	3/22	4/10	5/16	6/8	7/11			
	Time (MST)	11:20	23:40	7:50	0:00	14.20	3:30	3:00	2:20	3:20			
	Wind Direction (Deg.)	298	108	132	CALM	144	104	99	46	89			
	Wind Speed (MPH)	4	5	6		9	1	4	1	2			
022	Value (ug/m^3)	13.7	13.5	16.9	17.8	17.4	13.0	6.7	1.5	13.7			
	Date	11/1	12/7	1/8	2/1	3/14	4/16	5/3	6/17	7/6			
	Time (MST)	13:35	14:35	5:10	7:35	0:10	10:25	5:40	2:15	2:55			
	Wind Direction (Deg.)	266	125	101	115	CALM	266	117	96	88			
	Wind Speed (MPH)	6	2	5	10		6	8	2	1			
024	Value (ug/m^3)	22.1	10.0	5.9	3.0	4.6	4.3	4.6	817	10.0			
	Date	11/7	12/14	1/1	2/4	3/14	4/8	5/20	6/15	7/16			
	Time (MST)	3:20	2:30	14:20	12:30	4:30	9:55	5:10	8:10	5:15			
	Wind Direction (Deg.)	103	291	286	148	168	342	179	330	119			
	Wind Speed (MPH)	4	9	6	19	7	3	4	2	4			

(1) Side-by-side monitoring of H_2S in Trailer 023 and of SO_2 in Trailer 021 was initiated, as a data reliability check, for three months beginning 1 January, 1976. Therefore, no SO_2 data were taken at 023. The data from the second SO_2 analyser at 021 are reported in the row for 023 for January, February and March.

(2) Missing Data

*All data below minimum detectable limit

Table II B-8
1- HOUR MAXIMUM CONCENTRATIONS

H_2S

Constituent

		1975		1976									
Trailer	Item	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.
020	Value (ug/m^3)	2.0	.8	1.0	.2	5.0	30.9	2.3	0.7	1.0			
	Date	11/10	12/12	1/24	2/15	3/8	4/5	5/25	6/6	7/5			
	Time (MST)	9:25	2:05	11:05	8:55	10:15	15:55	21:30	9:00	4:25			
	Wind Direction (Deg.)	229	57	CALM	115	310	295	118	179	108			
	Wind Speed (MPH)	7	2		5	1	4	(2)	(2)	(2)			
023	Value (ug/m^3)	6.9	10.0	20.5	7.4	3.5	7.1	6.8	9.0	7.4			
	Date	11/29	12/6	1/10	2/11	3/5	4/26	5/6	6/17	7/30			
	Time (MST)	8:50	8:50	15:15	14:55	4:55	13:50	6:40	6:05	14:20			
	Wind Direction (Deg.)	140	57	7	202	CALM	211	292	128	311			
	Wind Speed (MPH)	2	3	3	12		18	6.8	2	14			
021	Value (ug/m^3)	4.6	2.8	4.4(1)	3.7(1)	5.5(1)**	5.1	8.1	6.6	2.8			
	Date	11/27	12/27	1/2	2/13*		4/18	5/25	6/6	7/9			
	Time (MST)	9:40	11:25	8:20	21:35-22:50		5:00	21:15	9:20	4:40			
	Wind Direction (Deg.)	126	248	100	195-179		CALM	88	133	82			
	Wind Speed (MPH)	7	9	1	1-2			4	11	4			
022	Value (ug/m^3)	1.4	2.0	(3)	.3	.3	7.1	2.8	1.4	6.5			
	Date	11/25	12/14		2/26	3/13	4/22	5/1	6/10	7/7			
	Time (MST)	14:05	10:35		9:55	11:55	10:55	0:00	4:20	4:00			
	Wind Direction (Deg.)	304	271		113	114	219	107	90	116			
	Wind Speed (MPH)	7	9		5	9	9	5	4	6			
024	Value (ug/m^3)	1.3	8.2	9.8	.8	2.4	7.7	2.8	1.4	2.8			
	Date	11/25	12/24	1/6	2/8	3/25	4/12	5/12	6/28	7/12			
	Time (MST)	13:00	10:55	6:50	9:45	17:35	14:45	09:05	10:15	13:55			
	Wind Direction (Deg.)	321	CALM	338	132	100	204	352	304	316			
	Wind Speed (MPH)	10		1	7	2	13	11	3	15			

(1) Side-by-side monitoring of H_2S in Trailer 023 and of SO_2 in Trailer 021 was initiated, as a data reliability check, for three months beginning 1 January, 1976. Therefore, no H_2S data were taken at 021 and the data from the second H_2S analyzer at 023 are reported in the row for 021 for January, February, and March.

* Two maxima reported on same day.

** Maxima reported at 4 different times: 3/26 @ 22:15, 8mph. @ 146; 3/26 @ 23:20, 5mph. @ 118;
3/27 @ 0:25, 6mph. @ 136; 3/27 @ 2:40, 4mph. @ 101.

(2) Missing Data

(3) All data a minimum detectable limit.

Particulate Constituent

Table II B-9

24- HOUR MAXIMUM CONCENTRATIONS
1975-1976
Midnight - Midnight

Trailer	Item	1975		1976									
		Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.
020	Value (ug/m^3)	20.0	11.0	19.0	25.0	25.0	79.0	55.0	39.0	27.0			
	Date	11/18	12/12	1/25	2/4	3/2	4/2	5/5	6/11	7/15			
	(1) 24-hr. ave. Wind Direction (Deg)	354	119	111	124	271	42	82	186	32			
	Max. 1-hr. ave. Wind Speed (MPH)	11	12	8	14	9	7	8	(2)	(2)			
	Wind Speed - 24-hr. ave. (MPH)	5	7	4	9	3	4	3	(2)	(2)			
023	Value (ug/m^3)	23.0	16.0	13.0	19.0	45.0	96	32.0	82.0	53.0			
	Date	11/18	12/12	1/24	2/4	3/2	4/2	5/3	6/10	7/12			
	(1) 24-hr. ave. Wind Direction	245	168	273	173	239	260	188	184	181			
	Max. 1-hr. ave. Wind Speed	19	24	14	32	16	11	13	25	17			
	Wind Speed - 24-hr. ave.	10	13	6	17	9	5	7	16	8			
021	Value (ug/m^3)	15.0	50.0	42.0	21.0	59.0	90	34.0	42.0	28.0			
	Date	11/10	12/14	1/4	2/4	3/2	4/2	5/4	6/11	7/17			
	(1) 24-hr. ave. Wind Direction	102	300	350	116	279	78	128	152	92			
	Max. 1-hr. ave. Wind Speed	13	14	11	15	14	10	14	15	14			
	Wind Speed - 24-hr. ave.	7	8	5	10	5	5	8	10	5			
022	Value (ug/m^3)	32.0	30.0	14.0	17.0	30.0	60	48.0	37.0	31.0			
	Date	11/25	12/4	1/25	2/4	3/2	4/2	5/4	6/11	7/7			
	(1) 24-hr. ave. Wind Direction	290	118	95	111	263	47	136	196	121			
	Max. 1-hr. ave. Wind Speed	12	12	10	14	12	13	9	13	9			
	Wind Speed - 24-hr. ave.	6	9	5	8	5	5	6	7	8			
024	Value (ug/m^3)	24.0	15.0	60.0	19.0	42.0	116	35.0	77.0	31.0			
	Date	11/27	12/12	1/25	2/29	3/2	4/2	5/3	6/10	7/16			
	(1) 24-hr. ave. Wind Direction	150	150	56	166	236	304	195	168	122			
	Max. 1-hr. ave. Wind Speed	10	19	7	21	20	13	(2)	19	5			
	Wind Speed - 24-hr. ave.	6	10	3	14	10	5	(2)	12	4			

(1) Vector Averages
(2) Missing Data

Methane HC
Constituent

Table II B-10

3 - HOUR MAXIMUM CONCENTRATIONS
1975-1976
(6-9 a.m.)

		1975		1976									
Trailer	Item	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.
020	Value (ug/m^3)		678.9	698.1	675.5	NO	598.1	571.0	1022.9	1045.0			
	Date	NO	12/24	1/24	2/7		4/21	5/26	6/29	7/13			
	Wind Direction (Deg.)		57	309	CALM		99	42	(1)	98			
	Wind Speed (MPH)	DATA	1	2		DATA	2	(1)	(1)	(1)			
023	Value (ug/m^3)	1172.8	1098.2	1075.1	1533.8	1170.4	1123.0	1092.5	1268.3	803.5			
	Date	11/12	12/14	1/11	2/21	3/14	4/27	5/13	6/24	7/13			
	Wind Direction (Deg.)	115	312	140	203	182	84	77	55	75			
	Wind Speed (MPH)	2	12	4	2	20	3	2	2	2			

(1) Missing Data

Non-Methane HC
Constituent

Table II B- 11

3 - HOUR MAXIMUM CONCENTRATIONS

1975-1976
(6-9 a.m.)

		1975		1976									
Trailer	Item	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.
020	Value (ug/m^3)		116.7	63.3	126.7	NO	58.6	39.8	98.2	177.4			
	Date	NO	12/5	1/24	2/11		4/24	5/27	6/26	7/13			
	Time (MST)		---	---	---	DATA	---						
	Wind Direction (Deg.)	DATA	139	307	93		134	47	288	98			
	Wind Speed (MPH)		9	2	4		6	(1)	(1)	(1)			
023	Value (ug/m^3)	590.0	286.7	553.3	926.7	560.0	1992.6	1816.4	2596.6	2520.0			
	Date	11/13	12/5	1/1	2/26	3/31	4/29	5/1	6/27	7/3			
	Time (MST)	---	---	---	---	---	---						
	Wind Direction (Deg.)	126	105	264	148	163	288	81	62	51			
	Wind Speed (MPH)	3	3	4	6	3	2	3	3	3			
021	Value (ug/m^3)												
	Date												
	Time (MST)												
	Wind Direction (Deg.)												
	Wind Speed (MPH)												
022	Value (ug/m^3)												
	Date												
	Time (MST)												
	Wind Direction (Deg.)												
	Wind Speed (MPH)												
024	Value (ug/m^3)												
	Date												
	Time (MST)												
	Wind Direction (Deg.)												
	Wind Speed (MPH)												

(1) Missing Data

CO
Constituent

Table II B-12

1 - HOUR MAXIMUM CONCENTRATIONS

1975-1976

		1975							1976				
Trailer	Item	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.
020	Value (ug/m^3)	NO DATA	501.4	568.1	NO DATA	NO DATA	NO DATA	1688.8	1244.5	1160.5			
	Date		12/30	1/24				5/20	6/1	7/25			
	Time (MST)		0:35	11:05				15:55	10:35	13:30			
	Wind Direction (Deg.)		CALM	CALM				CALM	CALM	107			
	Wind Speed (MPH)									(1)			
023	Value (ug/m^3)	3157.6	2032.9	3538.8	3009.1	1861.8	1972.3	2011.5	2746.6	(1)			
	Date	11/26	12/11	1/6	2/27	3/22	4/5	5/13	6/12	(1)			
	Time (MST)	1:20	11:00	13:20	21:55	22:25	14:20	8:10	12:55	(1)			
	Wind Direction (Deg.)	CALM	221	302	123	125	158	25	221	(1)			
	Wind Speed (MPH)		8	11	2	5	16	6	13	(1)			
021	Value (ug/m^3)												
	Date												
	Time (MST)												
	Wind Direction (Deg.)												
	Wind Speed (MPH)												
022	Value (ug/m^3)												
	Date												
	Time (MST)												
	Wind Direction (Deg.)												
	Wind Speed (MPH)												
024	Value (ug/m^3)												
	Date												
	Time (MST)												
	Wind Direction (Deg.)												
	Wind Speed (MPH)												

(1) Missing Data

NO
Constituent

Table II B-13

1 - HOUR MAXIMUM CONCENTRATIONS

1975-1976

		1975		1976									
Trailer	Item	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.
020	Value (ug/m^3)	27.8	37.8	37.8	30.9	44.3	64.1	78.6	62.3	30.6			
	Date	11/3	12/30	1/17	2/27	3/2	4/26	5/25	6/17	7/1			
	Time (MST)	5:15	3:00	21:25	3:55	7:30	1:50	22:55	18:35	16:25			
	Wind Direction (Deg.)	114	137	136	135	CALM	13	112	125	288			
	Wind Speed (MPH)	3	9	12	10		1	(1)	(1)	(1)			
023	Value (ug/m^3)	4.1	25.0	1.4	15.4*	21.5	23.2	19.7	17.6	17.0			
	Date	11/29	12/10	1/21	2/24-25	3/4	4/20	5/30	6/19	7/23			
	Time (MST)	9:15	6:35	12:30	23:10 7:45	0:30	20:15	19:10	19:35	6:10			
	Wind Direction (Deg.)	205	101	331	191 189	261	197	238	197	56			
	Wind Speed (MPH)	2	3	2	2 5	2	10	7	7	2			
021	Value (ug/m^3)												
	Date												
	Time (MST)												
	Wind Direction (Deg.)												
	Wind Speed (MPH)												
022	Value (ug/m^3)												
	Date												
	Time (MST)												
	Wind Direction (Deg.)												
	Wind Speed (MPH)												
024	Value (ug/m^3)												
	Date												
	Time (MST)												
	Wind Direction (Deg.)												
	Wind Speed (MPH)												

(1) Missing Data

*Two maxima.

NO_2

Constituent

Table II B-14

1 - HOUR MAXIMUM CONCENTRATIONS

1975-1976

		1975		1976									
Trailer	Item	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.
020	Value (ug/m^3)	29.2	23.1	34.5	19.7	24.5	51.0	116.5	26.4	11.9			
	Date	11/6	12/12	1/28	2/5	3/2	4/17	5/15	6/15	7/17			
	Time (MST)	7:45	10:40	11:55	9:00	6:25	20:10	03:20	22:25	20:50			
	Wind Direction (Deg.)	126	135	304	291	CALM	CALM	293	86	82			
	Wind Speed (MPH)	6	5	2	8			10	(1)	(1)			
023	Value (ug/m^3)	17.5	47.6	5.5	2.2	4.5	10.9	16.1	20.1	10.5			
	Date	11/18	12/9	1/5	2/21	3/6	4/20	5/20	6/27	7/28			
	Time (MST)	20:40	11:00	11:00	2:40	9:30	11:05	19:35	7:20	9:25			
	Wind Direction (Deg.)	308	13	189	208	332	198	277	55	79			
	Wind Speed (MPH)	13	2	11	1	2	5	6	3	3			
021	Value (ug/m^3)												
	Date												
	Time (MST)												
	Wind Direction (Deg.)												
	Wind Speed (MPH)												
022	Value (ug/m^3)												
	Date												
	Time (MST)												
	Wind Direction (Deg.)												
	Wind Speed (MPH)												
024	Value (ug/m^3)												
	Date												
	Time (MST)												
	Wind Direction (Deg.)												
	Wind Speed (MPH)												

(1) Missing Data

O_3

Constituent

Table II B-15
1 - HOUR MAXIMUM CONCENTRATIONS

1975-1976

		1975								1976			
Trailer	Item	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.
020	Value (ug/m^3)	72.3	102.6	51.0	51.1	63.2	131.1	134.6	131.7	122.1			
	Date	11/7	12/13	1/11	2/4	3/19	4/9	5/25	6/1	7/3			
	Time (MST)	12:25	14:45	11:55	6:20	5:00	16:00	10:25	8:55	11:30			
	Wind Direction (Deg.)	232	121	165	80	256	246	292	172	346			
	Wind Speed (MPH)	9	4	5	11	7	10	(1)	(1)	(1)			
023	Value (ug/m^3)	53.4	106.0	56.3	52.9	84.3	123.6	113.8	115.9	118.8			
	Date	11/6	12/13	1/5	2/10	3/19	4/26	5/19	6/24	7/23			
	Time (MST)	14:15	22:50	3:55	0:20	5:10	14:05	11:05	11:55	22:15			
	Wind Direction (Deg.)	230	316	149	214	226	205	13	209	137			
	Wind Speed (MPH)	13	12	3	22	19	19	4	8	15			
021	Value (ug/m^3)												
	Date												
	Time (MST)												
	Wind Direction (Deg.)												
	Wind Speed (MPH)												
022	Value (ug/m^3)												
	Date												
	Time (MST)												
	Wind Direction (Deg.)												
	Wind Speed (MPH)												
024	Value (ug/m^3)												
	Date												
	Time (MST)												
	Wind Direction (Deg.)												
	Wind Speed (MPH)												

(1) Missing Data

Table II B-16

MONTHLY AVERAGE AMBIENT AIR CONSTITUENT CONCENTRATIONS
OF GASES AND PARTICULATES ($\mu g/m^3$)
1975-1976

Trailer	Item	1975		1976									
		Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.
020	NO ($\mu g/m^3$)	2.6	3.4	12.5	5.7	(1)	(1)	(1)	(1)	4.9			
023		.0**	2.5	0.0*	(1)	2.0	.4	1.5	2.2	1.2			
020	NO_2 ($\mu g/m^3$)	8.5	2.2	4.8	2.1	(1)	(1)	(1)	(1)	(1)			
023		.8	2.6	(1)	(1)	.1	0.3	1.3	1.5	.2			
020	O_3 ($\mu g/m^3$)	30.9	32.7	35.7	30.7	40.2	66.5	72.7	66.3	69.8			
023		39.2	38.2	37.1	41.2	45.2	68.0	78.4	74.5	81.5			
020	Non-Methane H.C. ($\mu g/m^3$)	No Data	26.4	20.5	(1)	(1)	(1)	(1)	60.3	77.6			
023		303.8	151.3	171.2	389.7	388.7	818.3	1194.6	1687.9	( )			
020	CH_4 ($\mu g/m^3$)	No Data	579.5	592.5	(1)	(1)	(1)	533.1	928.9	958.4			
023		920.6	909.6	862.5	1046.6	1046.6	1007.2	948.0	974.5	(1)			
020	CO ($\mu g/m^3$)	No Data	(1)	408.5	(1)	(1)	(1)	1294.8	562.8	444.0			
023		1847.3	(1)	1787.3*	1161.8	1271.5	657.0	(1)	1821.5	(1)			
020	SO_2 ($\mu g/m^3$)	.0	.0	.0	.0	.0	.0	1.1	1.1	.4			
021		.9	.0	1.7	.2	.6	.8	1.3	(1)	(1)			
022		.1	1.4	1.9	1.7	1.4	1.0	0.5	.0	.7			
023		.0	.2	1.1 (2)	.1 (2)	2.6 (2)	.5	0.6	.3	.1			
024		1.1	.8	.2	.1	.2	.3	0.5	1.1	.8			
020	H_2S ($\mu g/m^3$)	.1	.0	.0	.0	.1	.3	.0	.0	.0			
021		.1	.2	0.2 (2)	.1 (2)	.1 (2)	.7	.6	.8	.0			
022		.0	.1	.0	.0	.0	.6	.2	.1	(1)			
023		.4	.9	3.3	.9	.4	.3	.6	.7	.1			
024		.0	.1	.4	.0	.0	.0	.0	.0	.1			
020	Particulate ($\mu g/m^3$)	5.0	2.8	3.2	3.2	7.5	14.7	10.5	12.5	17.9			
021		4.3	3.7	3.4	2.7	6.9	14.0	10.3	13.3	16.7			
022		4.6	2.8	3.3	2.6	5.7	12.5	7.6	10.3	11.6			
023		3.9	2.3	2.8	2.4	5.5	9.8	8.9	11.4	13.4			
024		5.3	2.5	3.3	3.0	7.5	14.4	10.2	14.2	16.4			

(1) Few or no data collected because of instrument malfunction

(2) Side-byside monitoring of H_2S in Trailer 023 and of SO_2 in Trailer 021 was initiated as a data reliability check for three months beginning 1 January, 1976. Therefore, no SO_2 data were taken at 023 and no H_2S data were taken at 021. The data from the second SO_2 analyzer at 021 are reported in the row for 023 for January, February and March. Data from the second H_2S analyzer at 023 are reported in the row for 021 for January, February and March.

* 50% or Less Data

** .0 indicates below limits of detectability of the recording instruments.

The H_2S concentrations for May through July were below detection limits (7 ug/m^3) for almost the entire period at all stations. The maximum hourly average, 9 ug/m^3, occurred at Station 023 on June 17. Neither the hourly H_2S data (Table II B-8) nor the monthly averages (Table II B-16) are significantly different from previous monitoring data.

With reference to test results reported in Summary Report #7 concerning a three-month study conducted during January, February, and March in which two identical, side-by-side SO_2 analyzers were operated in Station 021 and two H_2S analyzers were operated in Station 023 the following corrections are noted:

a. The maximum reading on one SO_2 instrument on March 22 was 54.6 ug/m^3 and not 39 as reported in the text. This represents a difference of approximately 36 ug/m^3 from the co-located instrument. The specified accuracy of the analyzers is ± 1% (or ± 26 ug/m^3). If the actual (true) SO_2 value were 35 ug/m^3, both analyzers would have been operating within specified accuracy.

b. An undetected typographical error indicated the maximum H_2S reading to be 25.0 instead of 20.5 ug/m^3.

As observed in 1975, ozone levels were considerably higher during May, June, and July than during earlier months of the year. This is to be expected because of longer days, higher temperatures, and greater insolation. Ozone levels generally followed a typical diurnal pattern with maximum values being reached during the afternoon. Several nighttime increases in ozone were observed, however, the maximum value of 119 ug/m^3 for July at Station 023 occurred between 2200 and midnight after increasing for several hours. A similar increase and maximum value was observed simultaneously at Station 020. This occurred during a significant increase in wind speed (from 12 to 24 mph) also accompanied by a change in wind direction. This is indicative of a frontal passage, thus a contribution by stratospheric ozone appears to be a definite possibility. A detailed meteorological analysis has not been performed to confirm this, however. The maximum hourly values for May, June, and July are given in Table II B-15. The ozone standard (160 ug/m^3) was not exceeded at any time, and all maximum values are normal except for the case of Station 023 for July as mentioned above.

The NO and NO_2 levels are generally below the detection limits for May, June, and July. The levels at Station 020 were consistently higher than at 023, undoubtedly because of the influence of traffic on the valley site. The peak NO value of 78 ug/m^3 was reached, probably because low wind speeds and relatively poor diffusion allowed a buildup of the NO_2. Overall, neither NO nor NO_2 were significantly different from previous months.

Non-methane hydrocarbons at Station 023 continued at the high levels observed during the last quarter. Levels at Station 020 were slightly increased above previous months. The peak 6-to-9 A.M. value occurred at

Station 023 on June 27, and reached 2596 ug/m^3. Methane values were not significantly changed with the peak value of 1284 ug/m^3 reached on June 24 at Station 023 (Table II B-10).

Carbon monoxide at Station 023 was not significantly changed, and remained at a high level for such a remote area. The peak CO value, 2746 ug/m^3, occurred at Station 023 on June 12. CO levels in the valley were lower than on the mountain in spite of the greater traffic in the valley. The peak valley reading (Station 020) reached 1688 ug/m^3 on May 20 (Table II B-12).

Particulates were generally increased over winter-month values, but less than the April values. The peak 24-hour value was 82 ug/m^3 and occurred on June 10 at Station 023. This is well below the federal standard.

It is to be noted that over the 24-month baseline period, data errors have been detected which have necessitated updating the basic seven types of data tables reported in the monthly Radian reports. To report these errors specific cross-index tables have been included in Quarterly Data Report #8 as Tables II B-20 to II B-26. In the Summary Report Tables II B-1 to II B-16 have been so corrected.

Trace element analyses of particulates were performed at Station 023 on samples collected on cellulose filters every sizth day for one year. An analysis of these results follows.

During the calendar year 1975, special samples were taken of the ambient particulate matter as a part of the overall C-b Air Monitoring Program. The samples were acquired using the standard high volume samplers with special filter material. A low ash cellulosic filter material was used to collect the particulate samples. This permitted spark source mass spectrographic analysis for some 40-50 elements by providing consistent low background levels. Additionally, the samples were analyzed for radium 226 and gross α and β radiation.

Two types of information were sought; the average atmospheric loading of the trace elements and the short term variability of the particulate matter. This was accomplished by collecting 14 to 16 filters per quarter, selecting a sample at random for single analysis and obtaining the composite of the remainder for the quarterly average. This would enable an assessment of the variability since a significant deviation of the single sample from the composite would indicate the need for a more intensive program. Principal conclusions are:

(1) The trace element magnitudes vary somewhat over the one year period. Variations in loadings of individual elements are usually within an order of magnitude. This is within the analytical variation expected of spark source mass spectrometry.

(2) The single samples do not show unexpected deviations from the composites. The analyses of the composite sample is

expected to be the more accurate because of the larger sample size available. This may be seen in that more elements are above detection limits in the composites than in the single samples. There are no unexpected variations in the single samples.

(3) The uniformity of the results indicates that these data should provide a representative baseline against which to compare ambient air particulates for the majority of the elements after development of Tract C-b.

The particulate loadings of each filter used for trace element analysis are shown by quarter in Tables II B-17 through II B-20. There is a fairly wide variability in sample loadings, from 9.6986 grams in filter 307 to 0.0015 grams on filter 1200. However, the comparison of composite and single filters is facilitated by the fact that the single filters are similar in weight to the average weight of the composite sample. Table II B-21 shows the complete set of trace element data for comparison of the ambient air loadings in ug/m^3. The variability in filter weights accounts generally for variations in trace element loadings. Table II B-22 makes a similar comparison for radioactivity. The radioactivity, measured as radium 226 and gross α and β, is best characterized as very low, too low in fact for standard counting times to give reasonable counting statistics.

Perhaps the easiest way to compare the data is by the concentrations of selected trace elements in the collected particulates. Table II B-23 offers this type of comparison.

A series of five soil samples from the western Wyoming area are given for comparison in Table II B-23. These samples were recently analyzed as a part of a baseline environmental assessment for a new power plant. Variations between the Tract C-b particulate samples and those of the Wyoming soils can be noted. Fluorine, arsenic, and selenium are notably higher at Tract C-b; however, volatile elements such as these are generally subject to the greatest analytical error in spark source mass spectrometry. (The Wyoming soils were analyzed by atomic absorption). Uranium is also higher in the Tract C-b samples.

In this reporting period the following site location changes and program additions have been made in the meteorological station network (Figure II B-1). In an effort to improve knowledge of the wind and temperature patterns, the three mechanical weather stations (Stations 031, 032, and 033) were relocated on April 30, 1976 and redesignated as Stations 041, 042, and 043, respectively. Subsequently, air diffusion modeling results indicated that an off-tract location for high ground-level concentrations of pollutants could be expected at the Collins Overlook site on the high-ground on the north side of Piceance Creek. Therefore, Station 042 was terminated on August 19, 1976 and that instrument moved to Station 044 on that data. Station locations are as follows:

Table II B-17 SUMMARY OF PARTICULATE LOADINGS FOR JANUARY-MARCH, 1975

Filter Number	Date Collected
006	1/9/75
007	1/16/75
008	1/25/75
009	1/28/75
010	2/6/75
011	2/12/75
012	2/19/75
013	2/27/75
014	3/8/75
015	3/18/75
016	3/25/75
017	3/31/75

Single Filter Sample:

Filter Number	009
Date	1/28/75
Particulate Loading	0.0317 grams
Flow Rate	49 cfm

Composite Filter Sample:

Filter Numbers	006,007,008,010,011,012, 013,014,015,016,017
Average Particulate Loading	0.0436 grams
Average Flow Rate	50 cfm

Table II B-18 SUMMARY OF PARTICULATE LOADINGS FOR APRIL-JUNE, 1975

Filter Number	Date	Flow (cfm)	Total Particulate Loading (grams)
307	4/6/75	48-46	0.6986
333	4/12/75	48-47	0.0325
352	4/18/75	48-47	0.0397
387	4/24/75	48-46	0.0133
425	4/30/75	46-44	0.0019
479	5/06/75	47-45	0.0710
478	5/12/75	47-45	0.0502
513	5/18/75	48-47	0.0663
514	5/24/75	48-46	0.0629
515	5/30/75	47-46	0.0484
516	6/05/75	47-45	0.0721
517	6/11/75	46-44	0.0513
518	6/19/75	47-44	0.1276
519	6/25/75	46-44	0.0559

Single Filter Sample:

Filter Number	387
Date	4/24/75

Composite Filter Sample:

Filter Numbers 307, 333, 352, 425, 478, 479, 513, 514, 515, 516, 517, 518, 519

Average Particulate Loading 0.1060 grams

Table II B-19 SUMMARY OF PARTICULATE LOADINGS FOR JULY-SEPTEMBER, 1975

Filter Number	Date	Flow (cfm)	Total Particulate Loading (grams)
520	7/1/75	47-44	0.0721
767	7/7/75	46-45	0.0268
768	7/13/75	47-47	0.0255
769	7/19/75	47-45	0.0240
770	7/25/75	44-43	0.0457
771	7/31/75	48-48	0.0277
772	8/6/75	45-46	0.0042
944	8/15/75	46-46	0.0440
945	8/21/75	46-46	0.0337
946	8/27/75	46-46	0.0376
947	9/2/75	44-46	0.0541
951	9/8/75	46-47	0.0362
950	9/14/75*	48-48	0.0093
949	9/20/75	46-48	0.0216
948	9/26/75	45-46	0.0168

Single Filter Sample:

Filter Number	770
Date	7/25/75

Composite Filter Sample:

Filter Numbers: 520, 767, 768, 769, 770, 771, 772, 944, 945, 946, 947, 951, 950, 949, 948

Average Particulate Loading 0.0310 Grams

*Filter 950 ran for only two hours, but this was corrected for in the calculations.

Table II B-20 SUMMARY OF PARTICULATE LOADINGS FOR OCTOBER-DECEMBER, 1975

Filter Number	Date	Flow (cfm)	Total Particulate Loading (grams)
1200	10/2/75	46-46	0.0015
1199	10/8/75	46-46	0.0087
1198	10/14/75	48-48	0.0153
1197	10/20/75	46-48	0.0060
1196	10/26/75	46-48	0.0046
1360	11/1/75	48-48	0.0126
1361	11/7/75	46-46	0.0263
1363	11/13/75	46-46	0.0078
1364	11/19/75	48-48	0.0016
1365	11/25/75	48-48	0.0083
1366	12/1/75	52-52	0.0022
1543	12/7/75	46-46	0.0354
1362	12/13/75*	48-48	0.0012
1367	12/19/75	47-48	0.0042
1542	12/25/75	48-48	0.0022
1541	12/30/75	48-48	0.0076

Single Filter Sample:

Filter Number	1363
Date	11/13/75

Composite Filter Sample:

Filter Numbers: 1200, 1199, 1198, 1197, 1196, 1360, 1361, 1362, 1364, 1365, 1366, 1367, 1541, 1542, 1543

Average Particulate Loading: 0.0092

* Filter 1362 ran for only 8 hours, but this was corrected for in the calculations.

TABLE II B-21
COMPARISON OF AMBIENT ATMOSPHERIC LEVELS OF TRACE ELEMENTS AT TRACT Cb FOR THE PERIOD JANUARY - DECEMBER 1975
$(\mathrm{ug/m^3})$

	Single Filter (1/28/75)	Composite (Jan-Mar)	Single Filter (4/24/75)	Composite (April-June)	Single Filter (7/25/75)	Composite (July-Sept)	Single Filter (11/13/75)	Composite (Oct-Dec)
Aluminum	1.6E-1	1.0E-1	4.8E-1	3.1E-1	M	M	4.5E-2	M
Arsenic	7.0E-4	1.0E-4	3E-4	3E-1	5E-5	3.6E-4	1.2E-4	2.9E-4
Antimony	1.7E-4	4.5E-5	1E-4	8E-5			1.3E-4	
Barium	2.4E-3	1.0E-3	1.5E-2	2.9E-2	6.3E-3	2.4E-3	4E-5	2.7E-4
Beryllium	2.0E-6	2.7E-7		3E-6				
Bismuth	3.3E-5	1.8E-5	2E-4	2E-4		4E-5		4E-5
Boron	8.2E-3	1.4E-2	NR	NR	NR	NR	NR	NR
Bromine	7.2E-5		4E-4	2E-5	3.3E-4	2.0E-4	5E-5	
Cadmium	8.2E-7		1E-4	2E-4	2E-5	6E-5		2E-5
Calcium	M	M	M	M	M	M	M	4.1E-2
Carbon	NR	NR	NR	NR	NR	NR	NR	NR
Cerium	4.9E-4	1.2E-4	1.5E-3	4.0E-3	4.7E-4	4.7E-4		2E-5
Cesium	1.2E-4	6.4E-5		1E-4	1.0E-4	5E-5		
Chlorine	2.6E-3	1.3E-3	2.4E-3	NR	<7.7E-4	<7.1E-4	3.4E-2	1.7E-3
Chromium	1.1E-3	6.7E-4	6E-4	4.3E-3	1.7E-4	<1.1E-3	1.4E-3	6E-5
Cobalt	3.9E-4	2.7E-4	2E-4	3E-4			NR	NR
Copper	1.8E-2	9.1E-3	3.1E-3	1.3E-2	1.7E-2	1.2E-2	7.8E-3	6.8E-3
Dyaprosium								
Erbium								
Europium				2E-5				
Fluorine	4.3E-3	9.3E-3	1.6E-2	NR	2.2E-2	2.0E-2	6.0E-3	4.5E-2
Gadolinium				1E-5				
Gallium	4.9E-4	1.2E-4	1E-4	1E-4	1.2E-4	6E-5		
Germanium		3.2E-5	4E-5	4E-5				
Gold								
Hafnium								
Holmium								
Indium	I.S.	I.S.	I.S.	I.S.	I.S.	I.S.	I.S.	I.S.
Iodine			7E-5	8E-5				
Iridium								
Iron	7.4E-2	3.3E-2	~8.1E-1	~8.1E-1	~2.3E-1	~3.1E-1	M	M
Lanthanum	7.3E-5	8.8E-5	1.7E-3	1.0E-3	1.8E-4	2.2E-4	2E-5	3E-5
Lithium	2.8E-4	1.1E-4	2.4E-3	3.1E-4	~9.1E-4	~1.0E-3	1.1E-4	6E-5
Lead	9.9E-5	2.4E-3	1.2E-2	5.8E-3	7.7E-3	7.1E-3	8.5E-4	1.2E-3
Lutecium								
Magnesium	4.7E-1	1.9E-1	1.8E-1	1.3E-1	9.1E-2	2.4E-1	M	M
Manganese	1.2E-2	2.7E-3	1.1E-2	8.1E-3	5.2E-3	7.4E-3	6.7E-4	1.6E-3
Mercury	~2.0E-5	<2.0E-5	1.6E-8	2.1E-8	~2.3E-5	~2.4E-5	<2.2E-5	<2.3E-5
Molybdenum	4.7E-4	2.3E-4		NR	5.4E-4	9E-5	4E-5	4E-5
Neodymium	9.5E-5	3.7E-4	1E-4	5E-4	1.1E-4	3.1E-4	4E-5	
Nickel	3.3E-4	3.5E-4	2E-4	NR		1.3E-4	1.8E-4	2.3E-4
Niobium	7.2E-5	5.6E-5	1.2E-3	2E-3	1.9E-4	1E-4		2E-5
Nitrogen	NR	NR	NR		NR	NR	NR	NR
Osmium								
Oxygen	NR	NR	NR		NR	NR	NR	NR
Palladium								
Phosphorus	4.7E-3	3.3E-3	1.4E-1	6.5E-2	6.1E-2	3.1E-2	2.5E-2	8.8E-2
Platinum								
Potassium	6.6E-1	9.7E-2	3.5E-1	2.0E-1	1.8E-1	2.2E-1	4.3E-2	M
Praseodymium	6.8E-5	2.6E-5	2E-4	2E-4	4E-5	1.2E-4		
Rhenium			I.S.	I.S.			I.S.	I.S.
Rhodium						~3E-5		
Rubidium	3.7E-3	1.6E-3	6E-4	5E-4	1.6E-3	3.3E-4	3E-5	1.5E-4
Ruthenium								
Samarium				2E-4			<4E-5	
Scandium			1E-4	2E-4		6E-5		4E-5
Selenium	7.8E-5	8.0E-8	4E-4	4E-5		5E-5	2E-5	
Silicon	M	M	~2.1E-0	~1.2E-0	M	M	M	M
Silver	1.3E-4	5.3E-5	2E-5	2E-5		3E-5	1.5E-4	
Sodium	5.8E-2	4.9E-2	1.1E-1	1.4E-1	9.1E-2	9.0E-3	4.5E-3	M
Strontium	6.2E-3	2.7E-3	1.3E-2	1.2E-2	<4.2E-3	1.9E-3	NR	
Sulphur	7.4E-2	7.2E-3	2.4E-1	8.5E-2	1.9E-2	3.8E-2	3.6E-2	1.6E-2
Tantalum					3E-5	3E-5	NR	2E-5
Tellurium	4.1E-5							
Terbium								
Thallium								
Thorium	3.1E-5	5.6E-5	2E-4	3E-4	3.3E-4	2.0E-4		
Thullium								
Tin	1.8E-3	5.9E-4	2E-4	2E-4	9E-5	1.3E-4	2E-5	4E-5
Titanium	8.8E-3	4.1E-3	1.1E-1	9.6E-2	7.7E-2	3.8E-2	1.6E-3	2.9E-3
Tungsten	3.3E-5	3.4E-5	2E-6	NR		2E-5		
Uranium	4.5E-5	6.4E-5	1E-4	2E-4		<8E-5		
Vanadium	1.5E-3	4.0E-4	2.1E-3	9E-4	1.1E-3	1.1E-3	4.0E-4	4.1E-4
Ytterbium							<5E-5	<2E-5
Yttrium	1.7E-4	1.1E-4	4E-4	5E-4	1.3E-4	1.6E-4		
Zinc	2.4E-2	9.2E-3	NR	NR	5.2E-3	5.5E-3	7.2E-4	2.9E-3
Zieconium	1.0E-3	2.4E-4	3.1E-3	3.8E-3	7.7E-4	8.1E-4	4E-5	1.3E-4

M = major constituent.
N.R. = not **reported** - either non-detectable by SSMS or resulting from a high blank valve.
I.S. = elements added for use as internal standards.
E-notation - for example 1×10^{-5} = 1E-5
Blanks indicate that elements are below detectable limits, ~10^{-6} $\mathrm{ug/m^3}$.

TABLE II B-22: RADIOACTIVITY - LEVELS OF Ra^{226}, GROSS α AND GROSS β FOR THE YEAR 1975

Radium-226 ($\mu g/m^3$)

	Single Filter	Composite
January-March	$< 10^{-16}$	$< 10^{-16}$
April-June	$< 10^{-16}$	$< 10^{-16}$
July-September	$1.7 \times 10^{-2} \pm 2.1 \times 10^{-20}$	$6.5 \times 10^{-22} \pm 6.5 \times 10^{-22}$
October-December	$4.7 \times 10^{-20} \pm 3.9 \times 10^{-21}$	

Gross Alpha (pci/m^3)

	Single Filter	Composite
January-March	$1.3 \times 10^{-3} \pm 8 \times 10^{-4}$	$6.4 \times 10^{-4} \pm 2.7 \times 10^{-4}$
April-June	$3.4 \times 10^{-4} \pm 1.3 \times 10^{-4}$	$6.3 \times 10^{-4} \pm 4 \times 10^{-4}$
July-September	$3.5 \times 10^{-4} \pm 2.3 \times 10^{-4}$	$4.3 \times 10^{-4} \pm 9.5 \times 10^{-5}$
October-December	$5.6 \times 10^{-4} \pm 2 \times 10^{-4}$	$2.0 \times 10^{-3} \pm 1.8 \times 10^{-4}$

Gross Beta (pci/m^3)

	Single Filter	Composite
January-March	$1.3 \times 10^{-1} \pm 8 \times 10^{-3}$	$1.1 \times 10^{-1} \pm 4 \times 10^{-3}$
April-June	$1.9 \times 10^{-1} \pm 4 \times 10^{-3}$	$7.1 \times 10^{-2} \pm 1 \times 10^{-3}$
July-September	$5.5 \times 10^{-2} \pm 3.5 \times 10^{-3}$	$2.3 \times 10^{-2} \pm 7 \times 10^{-4}$
October-December	$1.8 \times 10^{-2} \pm 6 \times 10^{-3}$	$2.7 \times 10^{-2} \pm 4.5 \times 10^{-4}$

TABLE II B-23
CONCENTRATIONS OF TRACE ELEMENTS IN PARTICULATE MATTER COLLECTED AT TRACT C-b DURING THE PERIOD JANUARY - DECEMBER 1975
(ppm in Dry Solid)

	Single Filter	Composite (Jan-Mar)	Single Filter (4/24/75)	Composite (Apr.-June)	Single Filter	Comp. (July Sept)	Single Filter (11/13/75)	Comp. (Oct-Dec)	Soil No. 1	Soil No. 2	Soil No. 3	Soil No. 4	Soil No. 5
Aluminum	7,700	910	M	5,500	M	M	11,000	M	9,700	57,000	116,000	51,000	23,000
Arsenic	150	140	38	5.5	1.9	20	28	59	2.4	2.3	2.0	1.2	1.2
Antimony	3.4	4.0	16	1.5			32		7.6	30	4.3	1.6	.95
Barium	150	64	2,200	520	250	140	10	55	130	310	280	310	190
Beryllium				0.59					.33	.43	1.6	2.4	1.4
Bismuth	70	5.3	26	3.6		2.3		8.7					
Boron	NR	NR	NR	NR	NR	NR	NR	NR	21.7	33.9	48.2	47.2	21.8
Bromine	19	7.3	60	0.28	13	12	13						
Cadmium	13		21	3.0	0.92	3.3		5.0	1.5	.70	.73	1.5	.38
Calcium	M	M	M	M	M	M	M	8,200	6.56%	1.14%	3.98%	1.01%	7.75%
Carbon	NR	NR	NR	NR	NR	NR	NR	NR					
Cerium	11	6.0	220	71	18	27		5.0					
Cesium				1.8	3.8	2.8							
Chlorine		13,000	350	NR	30	<65	8,100	350					
Chromium			85	75	15	<41	340	12	22.0	23	17	16	13
Cobalt			35	5.5			NR	NR	2.1	2.9	4.7	4.7	1.3
Copper	130	290	440	220	660	680	1,900	1,400	52				
Dysprosium													
Erbium													
Europium				.36									
Fluorine	16,000		2,300	NR	880	1,200	1,500	9,200	26.0	97	134	140	68
Gadolinium				.20									
Gallium	1.6		15	2.1	4.8	3.5							
Germanium	1.3		5.1	0.67									
Gold													
Hafnium													
Holmium													
Indium	I.S.	I.S.	I.S.	I.S.	I.S.	I.S.	I.S.	I.S.					
Iodine	50		9.5	1.4									
Iridium													
Iron	M	M	M	M	M	M	M	M	.85%	1.63%	1.63%	1.91%	.99%
Lanthanum	6.4	2.8	250	17	7.3	13	5.4	5.5					
Lithium			350	55	<36	<57	25	11					
Lead		100	1,700	103	300	410	200	230					
Lutecium													
Magnesium	250,000	170,000	26,000	2,200	3,600	14,000	M	M	1.22	1.75%	1.75%	1.44%	1.87%
Manganese	3,300	3,400	1,600	140	200	420	160	330	280	175	248	252	235
Mercury	NR	NR		NR	NR	NR	NR	NR	<.015	.051	.035	.010	.012
Molybdenum	64		NR	NR	21	5.3	9.2	7.8	6.2	3.8	2.0	2.2	2.2
Neodymium		7.8	18	8.7	4.5	18	<8.6						
Nickel	2.3	13	23	NR	1.0	7.2	43	46	8.4	18	22	25	14
Niobium	1.7		170	34	7.5	5.7		4.6					
Nitrogen	NR	NR	NR	NR	NR	NR	NR	NR					
Osmium													
Oxygen	NR	NR	NR	NR	NR	NR	NR	NR					
Palladium													
Phosphorus	130,000	2,000	20,000	1,100	2,400	1,800	5,900	18,000					
Platinum													
Potassium	26,000	13,000	M	3,600	7,000	12,000	10,000	M					
Praseodymium		1.1	30	4.4	1.7	6.6							
Rhenium			I.S.	I.S.		<1.9	I.S.	I.S.					
Rhodium													
Rubidium	12	4.3	82	9.5	64	19	7.0	31					
Ruthenium													
Samarium				2.8			<10						
Scandium			20	2.8		3.4		7.8					
Selenium	7.4	3.1	54	0.75		3.0	5.4		.23	1.4	1.4	.72	.71
Silicon	120,000	20,000	M	21,000	M	M	M	M					
Silver		0.96	3.2	0.40		1.6	35		.60	.46	.50	.68	.29
Sodium	M	200,000	16,000	2,500	3,600	510.0	1,100	M					
Strontium	320	83	1,900	210		110	NR						
Sulphur	1,100	2,900	35,000	1,500	740	2,200	8,600	3,300					
Tantalum					1.1	1.9	NR	4.6					
Tellurium													
Terbium													
Thallium													
Thorium			35	5.9	13	11							
Thulium													
Tin	13	8.1	25	3.9	3.7	7.2	5.4	8.7					
Titanium	940	320	16,000	1,700	300	2,200	390	590					
Tungsten			0.32	NR		1.4							
Uranium		110	21	2.9	42	<4.6			.080	.38	.33	.30	.11
Vanadium	34	7.7	310	16		64	97	82	<40	<40	<40	<40	<40
Ytterbium							<12	<5.0					
Yttrium	11	6.5	54	8.7	5.1	9.1							
Zinc	210	440	NR	NR	200	310	170	590	140	670	191	301	56
Zirconium	3.7		440	67	30	46	9.7	26					

M = major constituent.
N.R. = not reported - either non-detectable by SSMS or resulting from a high blank valve.
I.S. = elements added for use as internal standards.
Blanks indicate that elements are below detectable limits, $\sim 10^{-6}$ ug/m^3.

On-Tract	Sta. 041	NW corner of SE ¼ of Section 1	R97W, T3S
	042	NE corner of SE ¼ of Section 1	R97W, T3S
	043	NW corner of the NE ¼ of Section 8	R96W, T3S
Off-Tract	044	East Central Portion of NW corner of Section 20 (Collins Overlook)	R96W, T2S

A series of tethersonde soundings were made during the period 15 June through 7 July 1976. The soundings were made alternately at Stations 020 and 023 (Figure II B-1). The primary purpose of the soundings was to enhance understanding of air flow in the Piceance Basin, particularly during periods when the air is hydrostatically stable. Thus the soundings were started as early as 0200 Mountain Standard Time. Six flights per day (3 per station) were made to altitudes as high as 2200 feet.

The acoustic sounder at Station 021 was terminated on 14 June 1976 and immediately moved to Station 020 so as to provide concurrent data with the tethersonde test at that location. It will continue in operation at location 020 to the end of the baseline period.

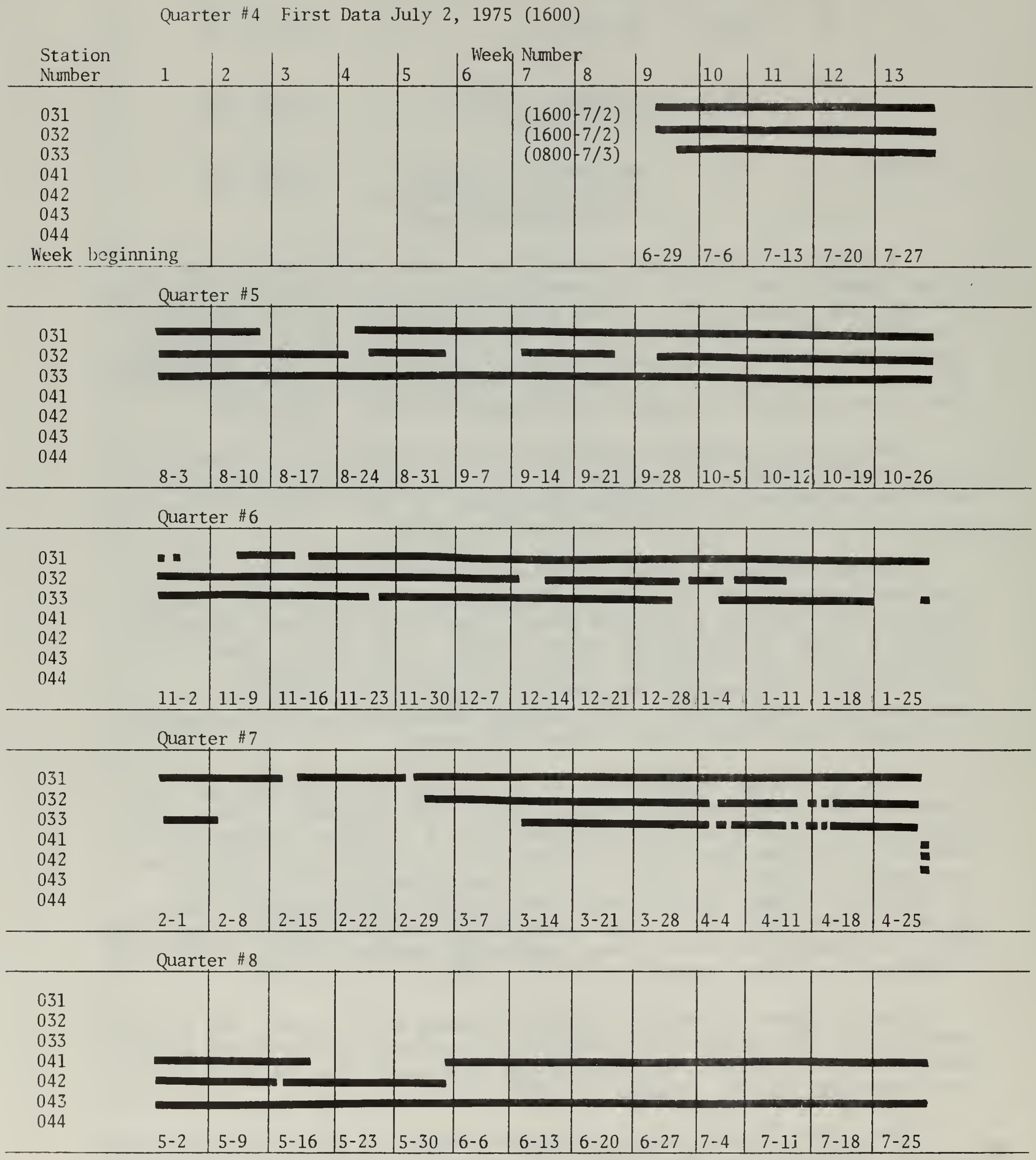
For the mechanical weather stations operational time records have now been prepared and are shown on Figure II B-2. In addition, station reliability (reported as station percent "up" time) has been analyzed (Table II B-24) by instrument and by station. For example, from 2 July 1975 through 30 April 1976 for the periods of actual operation, Stations 031, 032, and 033 had overall reliabilities of 93.2, 76.4, and 84.9 percent, respectively. The greatest down-time span was caused when instruments were taken to the factory for repair.

Monthly average temperatures on the plateau (Station 023) for the months of May, June, and July were 52 °F, 60 °F, and 69 °F. Those in Piceance Valley (Station 021) averaged about 1 °F cooler and were 51 °F for May, 59 °F for June, and 69 °F for July. Wide diurnal temperature variations are the rule rather than the exception on the C-b Tract. At Station 021 where the drainage flows are well developed the maximum diurnal temperature ranges were 48 °F, 55 °F, and 56 °F in May, June, and July. An hourly low of 16 °F was reported at Station 021 on 1 April 1976. A high of 101 °F was reported in July. (Tables II B-25 & 26).

Hourly figures (5 minute readings averaged over an hour) for relative humidity for the quarter have ranged from a minimum of 13 percent to a maximum of 100 percent. Averages by the hour range from 39 to 60 percent over this time period. (Table II B-26).

Five-minute maximum wind speeds have reached 44 mph in this reporting period. Hourly maxima have reached 29 mph on the plateau and 22 mph in

Figure II B-2 MRI STATION OPERATIONAL TIME RECORD



MRI STATION DATA TIMELINE

Table II B-24 MRI MECHANICAL WEATHER STATION OPERATIONAL TIME ANALYSIS

Station Number	Data Time Interval		Instrument Number	Station Time		Time in Hours			Percent Time	
	From	To		Days	Hours	Up	Down	Total	Lost	"Up"
031	7/2/75 (1600)	4/30/76 (1600)	SN 607	303	0	6632	640	7272	8.8	93.2
032	7/2/75 (1600)	1/15/76 (1900)	SN 707	197	3	4174	557	4731	11.8	88.2
	1/15/76 (1900)	3/2/76 (1500)	No Instr.	46	19	0	1123	1123	100.0	0
	3/2/76 (1500)	4/30/76 (1700)	Borrowed Instrument	59	2	1381	37	1418	2.26	97.7
	7/2/75 (1600)	4/30/76 (1700)	Both	303	0	5555	1717	7272	23.6	76.4
033	7/3/75 (0800)	2/19/76 (2400)	SN 706	208	7	4764	235	4999	4.7	95.3
	2/19/76 (2400)	3/15/76 (1600)	No Instr.	33	15	0	807	807	100.0	0
	3/15/76 (1600)	4/30/76 (1800)	SN 707	46	3	1055	52	1107	4.7	95.3
	7/3/75 (0800)	4/30/76 (1800)	Both	302	10	6164	1094	7258	15.1	84.9
041	5/1/76 (0000)	9/21/76 (2400)	SN 607	144	0	2881	575	3456	16.6	83.4
042	5/1/76 (0000)	6/29/76 (2400)	SN 706	60	0	846	594	1440	41.3	58.7
043	5/1/76 (0000)	9/2/76 (2400)	SN 707	125	0	2744	256	3000	8.5	91.5
044	8/19/76 (1500)	9/22/76 (1100)	SN 706	33	19	779	32	811	3.9	96.1

Table II B-25 METEOROLOGICAL SUMMARY: TEMPERATURE AND RELATIVE HUMIDITY 1975-1976

Trailer	Item	1975		1976										Annual
		Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	
020	Temperature, Hourly Max. (°F)	64	52	47	52	55	68	80(2)	86	93				
021		64	50	47	52	55	68	81	87	92				
022		68	52	48	52	55	67	79(2)	86(2)	94(2)				
023		63	50	47	48	51	63	74	82	87				
024		64	51	52	50	53	61(2)	77	84	90				
020	Temperature, Hourly Min. (°F)	-17	-14	-42	-21	-25	16	19(2)	17	40				
021		-21	-27	-50	-18	-34	12	16	17	34				
022		-18	-12	-36	-9	-13	18	21(2)	17(2)	44(2)				
023		4	6	- 6	6	5	22	27	21	50				
024		- 7	- 5	-26	0	-1	18(2)	25	20	46				
020	Temperature, Hourly Avg. (°F)	26	22	16	27	25	40	52	59	69				
021		24	19	12	26	24	40	51	59	69				
022		27	21	17	28	26	41	52	61	71				
023		32	28	24	31	29	42	52	60	69				
024		26	23	22	31	26	43(2)	52	61	70				
020	Rel. Hum., Hrly Max. (%)	100	98	99	98	99	100	98(2)	98	92				
021		100	100	100	100	100	100	100	100	100				
022		100	100	100	100	100	100	100(2)	98(2)	93(2)				
023		100	90	90	89	90	98	90	99	96				
024		100	98	100	100	100	100	100	100	99				
020	Rel. Hum., Hrly Min. (%)	16	32	28	21	20	14	13(2)	13	14				
021		19	36	35	25	24	17	19	15	15				
022		22	35	33	27	25	20	20(2)	13(2)	17(2)				
023		19	34	25	22	23	21	24	27	29				
024		22	32	29	26	30	21	21	16	16				
020	Rel. Hum., Hrly Avg. (%)	61	73	70	63	61	54	52	39	41				
021		70	81	78	70	67	59	60	44	46				
022		66	77	74	67	64	58	100	42	42				
023		53	62	62	57	56	53	51	44	47				
024		58	67	67	67	65	56	54	39	40				

(1) = Missing (2) = Partial Data Only

Table II B-26 METEOROLOGICAL SUMMARY: TEMPERATURE 1975-1976

MRI STATION	ITEM	1975		1976										ANNUAL
		NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	
031	Temperature Hourly Max. (^{O}F)	66	52	48	54	59	73	(3)						
032		69	56	44	(1)	68	84							
033		67	52	53	55(2)	49(2)	65							
041								84	91	101				
042								86	85(2)	(1)				
043								84	93	100				
044														
031	Temperature Hourly Min. (^{O}F)	-10	-10	-23	-14	-3	-3	(3)						
032		- 9	- 5	-19	(1)	-8	16							
033		- 3	- 4	- 8	2(2)	3(2)	11							
041								17	26	33				
042								19	40(2)	(1)				
043								18	26	44				
044														
031	Temperature Hourly Avg. (^{O}F)	22	20	15	26	28	40	(3)						
032		27	23	15	(1)	28	52							
033		29	23	21	9	26	37							
041								50	60	70				
042								51	64(2)	(1)				
043								50	61	71				
044														

(1) Missing data because of instrument malfunction.

(2) Partial data.

(3) Stations 031, 032, and 033 were relocated on 4/30/76 and subsequently designated 041, 042, and 043.

Piceance Valley. Hourly average (arithmetic) speeds at all stations were in the five to ten mph range; monthly vector averages ranged from 0.6 to 5.9 mph, (Tables II B-27 & 28). Typical monthly wind roses on the plateau and in the valley are presented in Figures II B-3 and II B-4 for Stations 023 and 021 respectively. Associated prevailing directions continue to be from the south-southwest on the plateau and from the east to east-southeast (down-valley) along Piceance Creek with the west-northwest (up-valley) direction occurring to a lesser extent.

II B-2 Low Altitude Meteorology

The quarterly wind rose at the 100-foot level on the meteorological tower (Figure II B-5) indicates that the prevailing wind direction is from the south-southwest for the February-through-April quarter (as reported in Radian's latest quarterly report), similarly to the previous quarter.

Estimations of hourly average values of Pasquill-Gifford atmospheric stability categories from the temperature difference data on the meteorological tower, revised to include the effects of wind speed, are given in Table II B-29 as frequency distributions. Hourly average stability classes by month for both years of baseline are presented on Table II B-30 as obtained from both the tower and the pyranometer. The tower wind speed adjustments now bring the tower data into much closer agreement with the pyranometer. The selective stippled regions on Table II B-30 indicate unstable regions occurring in the middle of the day and the stable regions occurring in the evening and early morning; whereas the clear region depicts neutral stability. Statistically speaking, D stability was predominant in the first year of baseline; thus far in the second year, D has predominated for five months, B for two months, A for one month, and E for one month.

II B-3 Upper Air Studies

The tethersonde studies* conducted at Station 020 in Piceance Valley and Station 023 on the plateau at the meteorological tower served two purposes. They provided additional insights into the complex wind and temperature patterns that exist in mountain-canyon terrain and provided additional insights into the interpretation of the acoustic sounder signatures.

Figure II B-6 is representative of the tethersonde flights and shows the vertical profiles of wind speed and direction, temperature, and relative humidity for three flights at each station (020, the top row; 023, the bottom) between the hours of 0400 Mountain Standard Time (MST) and 1134 MST.

Wind direction arrows are plotted so that they point in the direction

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*Two complete reports on the tethersonde studies, including comparisons with the acoustic sounder appear in Quarterly Data Report #8.

(Text continued on Page 61)

Table II B-27 METEOROLOGICAL SUMMARY: WIND SPEED & DIRECTION 1975-1976
(30 Foot Height)

Trailer	Item	1975		1976										Annual
		Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	
Tower 200'	Wind Speed, 5-Min. Max. (MPH) &	39	37	35	57	44	43	40	44	41				
	Associated Direction (Deg.)	308	200	198	217	187	248	254	166	208				
020	Wind Speed, Hourly Max. (MPH)	16	14	13	23	26	23	(1)	(1)	(1)				
021		20	17	14	20	22	25	18	22	15				
022		16	18	15	21	27	21	15(2)	15(2)	15				
023		33	25	27	32	28	25	23(2)	27	22				
024		28	21	21	29	35	25	17(2)	21	15				
020	& Associated Direction (Deg.)	147	104	140	304	292	154	(1)	(1)	(1)				
021		316	98	126	312	266	132	283(2)	321	99				
022		114	281	116	286	279	112	285(2)	122(2)	129				
023		176	192	202	188	190	179	195	219	217				
024		188	183	187	208	275	178	261	225	232				
020	Wind Speed, Hourly Avg. (MPH)	5	5	5	6	5	5	5(2)	(1)	4(2)				
021		5	5	5	6	6	6	5	7	5				
022		6	6	6	6	6	5	5	6(2)	5				
023		7	6	5	9	6	8	7	9	6				
024		6	5	4	8	8	8	6	8	5				
020	Wind Direction Hourly Avg. (Deg.)	117	112	110	132	127	118	102	126	87				
021		100	88	80	104	109	117	100	121	92				
022		119	110	106	112	109	106	90	129(2)	107				
023		205	173	195	190	213	203	201	189	170				
024		144	116	121	146	155	157	128	162	117				

(1) Missing data

(2) Partial data

Table II B-28

METEOROLOGICAL SUMMARY: WIND SPEED AND DIRECTION*
1975-1976

MRI STATION	ITEM	1975		1976										ANNUAL
		NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	
031	Wind Speed, Hourly Max. (MPH)	28	28	28	29	30	38	(3)						
032		17	19	15	(1)	25	28							
033		35	28	28	29(2)	38(2)	28							
041								28(2)	29(2)	28				
042								20	28	(1)				
043								28	28	28				
044														
031	Wind Direction (Deg.) Associated w/Max. Reading	344	150	167	201	184	181	(3)						
032		191	272	194	(1)	256	172							
033		136	156	221	222(2)	264(2)	107							
041								306	231	96				
042								202	231	(1)				
043								338	325	122				
044														
031	Wind Speed, Hourly Ave. (MPH)	7	6	6	8	8	8	(3)						
032		6	5	6	(1)	6	6							
033		8	7	7	9(2)	10(2)	9							
041								7(2)	9	7				
042								6	9(2)	(1)				
043								7	10	7				
044														
031	Wind Direction, Hourly Ave. (Deg.)	182	211	206	204	215	205	(3)						
032		170	148	157	(1)	174	169							
033		184	163	190	201(2)	195(2)	196							
041								173(2)	166	148				
042								179	152(2)	(1)				
043								188	179	176				
044														

* Speed @ 30'; Direction @7'

(1) Missing data because of instrument malfunction.
(2) Partial data.
(3) Stations 031, 032, and 033 were re-located on 4/30/76 as 041, 042, and 043 respectively.

Figure II B- 3 STATION 023 30' ELEVATION WIND ROSES ('75-'76)

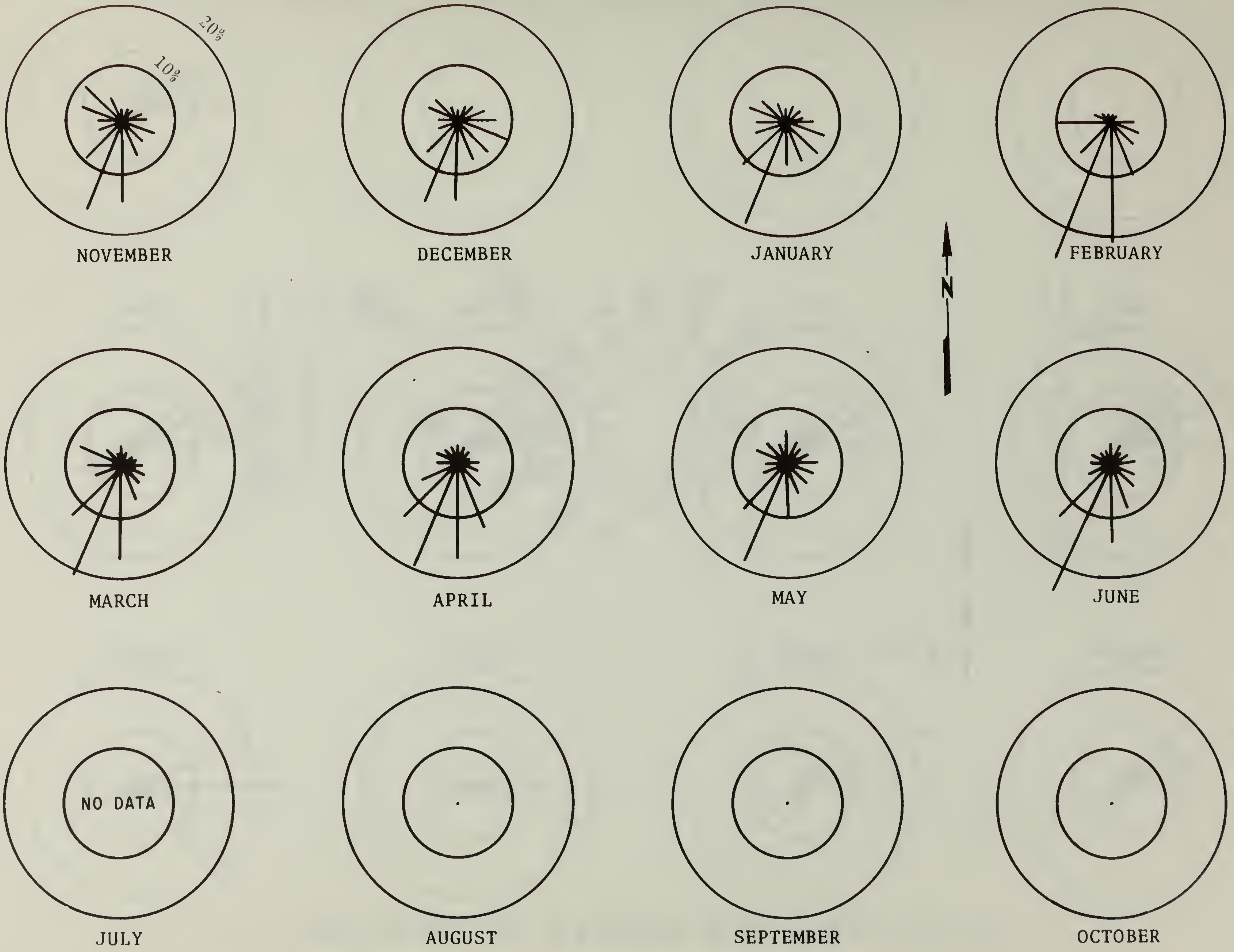


Figure II B-4 STATION 021 30' ELEVATION WIND ROSES ('75-'76)

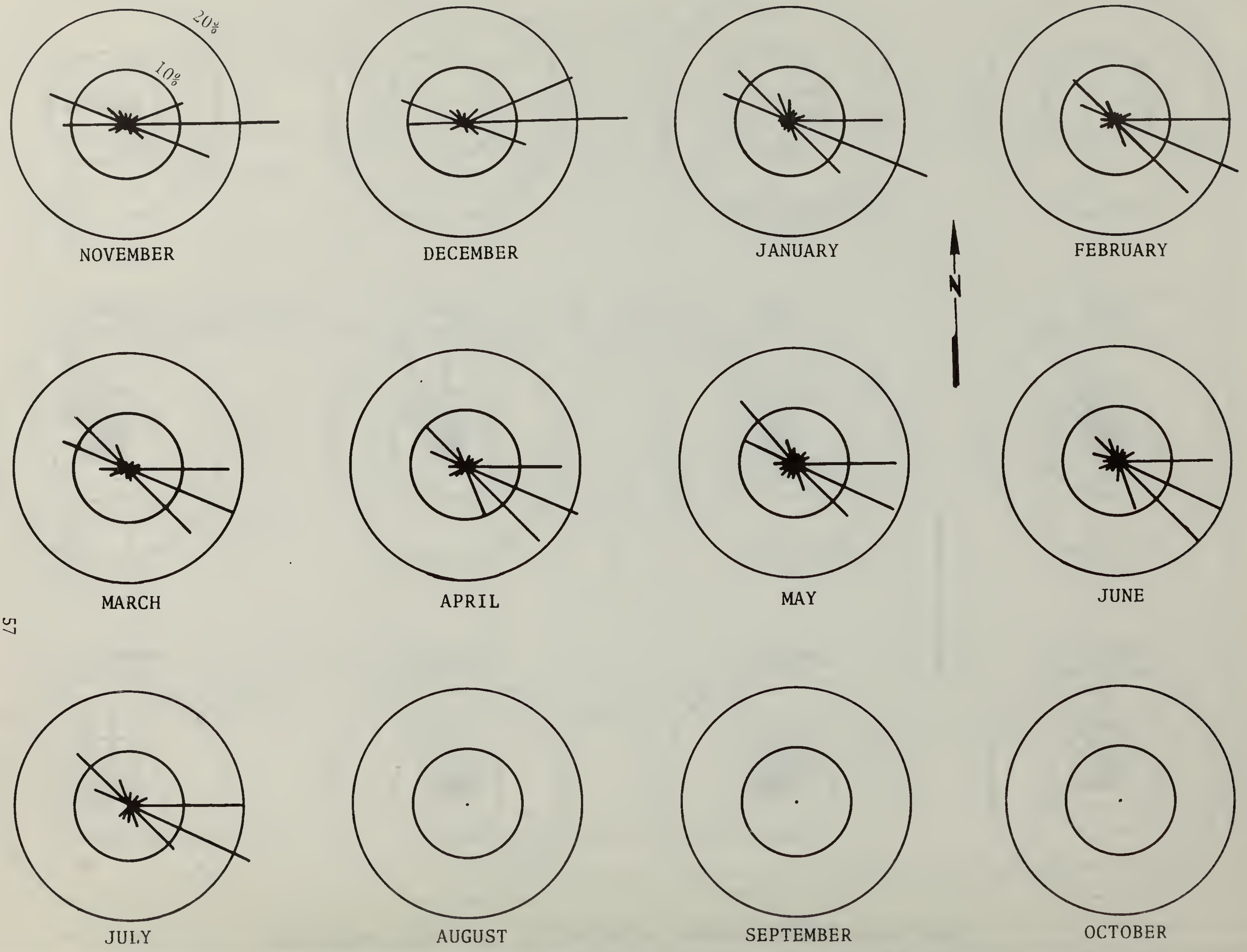


Figure II B-5

QUARTERLY WIND ROSE-100' LEVEL
MAR. '76 - MAY '76

TOTAL % OF CALMS DISTRIBUTED (0.81%)
TOTAL NO. OF 5-MIN. SAMPLES - 21230

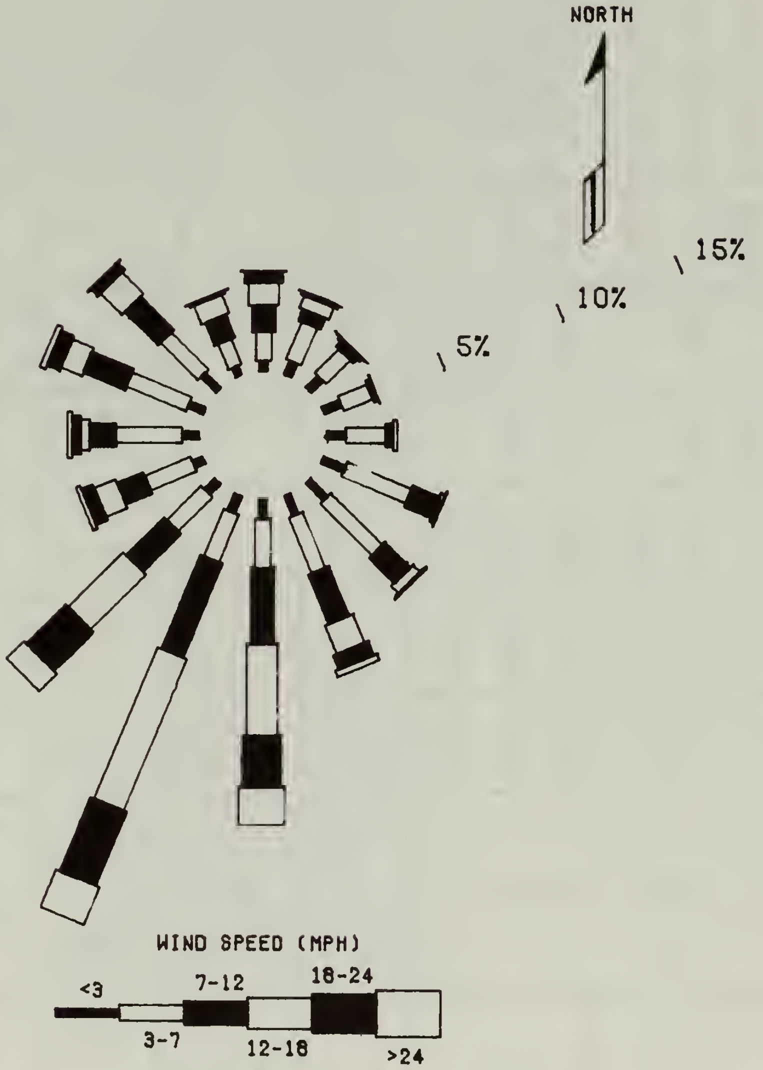


Table II B-66 METEOROLOGICAL SUMMARY: STABILITY CLASS FREQUENCIES (%) Source: Met. Tower[(1)] (30' to 200')

Pasquill-Gifford Stability Class	dT/dz Range for this Stability Class ($^oC/100m$)	1974		1975										Annual
		Nov.(3)	Dec.(3)	Jan.	Feb.	Mar.	Apr.	May	June	July(2)	Aug.	Sept.	Oct.	
A	<-1.9			8.3	1.0	1.1	12.0	7.4	8.6	0.0	2.4	5.8	8.1	6.1(4)
B	-1.9 to -1.7			5.5	4.4	10.3	23.5	30.6	25.6	85.7	19.3	23.4	20.6	18.1
C	-1.7 to -1.5			4.1	2.4	16.3	6.9	9.3	6.9	14.3	6.1	5.0	5.7	7.0
D	-1.5 to -0.5			33.0	43.4	60.9	36.3	30.0	27.0	0.0	25.8	13.4	28.3	33.1
E	-0.5 to +1.5			33.3	36.8	11.4	18.1	12.1	18.0	0.0	17.3	24.4	18.6	21.1
F	>1.5			15.8	12.0	0.0	3.2	10.6	13.9	0.0	29.1	28.0	18.7	14.6
Total				100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Pasquill-Gifford Stability Class	dT/dz Range for this Stability Class ($^oC/100m$)	1975		1976										Annual
		Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	
A	<-1.9	15.6	18.8	24.9	13.8	19.4	9.5	17.5	4.6	10.3				
B	-1.9 to -1.7	19.7	20.7	21.3	22.1	27.0	21.7	26.3	17.4	30.5				
C	-1.7 to -1.5	6.9	7.4	5.6	7.7	7.9	9.7	6.0	10.0	5.6				
D	-1.5 to -0.5	23.7	21.5	16.6	35.7	28.7	35.2	21.0	32.7	14.1				
E	-0.5 to +1.5	22.9	23.5	21.0	13.8	15.6	17.0	15.6	17.6	19.5				
F	>1.5	11.2	8.1	10.6	6.9	1.4	6.9	13.6	17.6	20.0				
Total		100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0				

(1) Adjusted for wind speed
(2) Partial Data
(3) Data are suspect
(4) Averaged from Jan. - Oct., excluding July

Table II B-30 AVERAGE HOURLY STABILITY CLASSES

SOURCE: TEMPERATURE DIFFERENCES BETWEEN 200 FT AND 30 FT. ON THE MET TOWER
(Adjusted for Wind Speed)

Month	Hour 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Average
Nov.*																									
Dec.*																									
Jan.75	D	D	D	D	D	D	D	D	E	E	E	E	D	D	D	D	D	D	D	E	D	D	D	D	D
Feb.	E	E	E	E	E	E	E	E	E	D	D	C	D	C	C	D	D	E	E	E	E	E	E	E	E
Mar.	D	D	D	D	D	D	D	D	C	C	C	C	C	C	D	D	C	C	D	D	D	D	D	D	D
Apr.	D	D	D	D	D	D	D	B	C	C	C	C	C	C	C	C	C	C	C	D	D	D	D	D	C
May	D	D	D	D	D	D	D	B	B	B	C	C	C	C	C	C	C	C	C	C	D	D	D	D	C
June	E	E	E	E	E	E	D	B	B	B	B	C	C	B	C	C	C	C	C	C	D	D	E	E	D
July	---------MISSING DATA-----------											B	B	B	B	B	B	C	-	-	-	-	-	-	B
Aug.	F	F	F	F	F	E	E	E	C	B	C	C	C	C	C	C	C	C	D	E	E	F	E	E	D
Sept.	F	E	E	F	F	F	F	E	B	B	B	B	B	C	B	B	C	B	E	E	E	F	F	F	D
Oct.	E	E	E	E	E	E	E	E	C	B	B	C	B	C	C	C	B	C	D	D	E	E	E	E	D
Nov.	D	D	D	D	D	D	D	D	C	B	B	B	C	B	B	B	B	C	D	D	D	D	D	D	D
Dec.	D	D	D	D	D	D	D	D	C	C	B	B	B	B	B	B	B	C	C	C	D	D	D	D	C
Jan.76	D	D	D	D	D	D	D	D	D	C	B	B	B	B	B	B	B	B	C	C	D	D	D	D	D
Feb.	D	D	D	D	D	D	D	D	C	C	C	C	C	C	C	C	B	B	C	D	D	D	D	D	C
Mar.	D	D	D	D	D	D	D	C	C	C	B	B	C	C	C	B	C	C	B	C	C	C	C	C	C
Apr.	D	D	D	D	D	D	D	B	B	C	C	C	C	C	C	C	C	C	C	D	D	D	D	D	C
May	E	E	E	E	E	E	D	B	B	B	B	B	B	B	B	B	B	B	C	D	D	E	E	E	C
June	E	E	E	E	E	E	E	C	C	C	C	C	C	C	C	C	C	C	C	D	E	E	E	E	D
July	E	E	E	E	E	F	E	B	B	B	B	B	B	C	B	B	B	B	B	D	E	E	E	E	D
Aug.																									
Sept.																									
Oct.																									

SOURCE: PYRANOMETER (DAYLIGHT ONLY)

Month		Hour 6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
Nov.																	
Dec.																	
Jan.'75						C	C	C	C	C	C	C					
Feb.						C	C	C	C	C	C	C					
Mar.						C	D	D	D	D	D	D					
Apr.						C	C	C	C	D	D	D					
May			C	C	C	C	C	C	C	C	D	D	D	D	D		
June			C	C	C	C	C	C	C	D	D	D	D	D	D		
July			C	C	C	B	B	B	C	C	C	C	C	C	D		
Aug.			C	C	C	C	C	C	C	C	C	D	D	D	D		
Sept.			C	C	C	C	C	C	C	C	C	C	C	D	D		
Oct.			C	C	C	C	C	C	C	C	C	C	D	D			
Nov.				C	C	C	C	C	C	C	C	D	D				
Dec.				C	C	C	C	C	C	C	C	D	D				
Jan.'76				C	C	C	C	C	C	C	C	D	D				
Feb.				C	C	C	C	C	C	C	C	C	D	D			
Mar.			C	C	C	C	C	C	C	C	C	C	D	D	D		
Apr.		C	C	C	C	C	C	C	C	C	C	D	D	D	D		
May		C	C	C	C	C	C	C	C	C	C	C	C	C	D		
June		C	C	C	C	C	C	C	C	C	C	D	D	D	D	D	
July		C	C	C	C	B	B	B	C	C	C	C	C	C	D	D	
Aug.																	
Sept.																	
Oct.																	

KEY:

- ▨ Unstable Cases
- D Neutral
- ▒ Stable

* Data are suspect

of flow with the plane of the paper taken as a horizontal plane. North is at the top of the diagram. Lines join plotted points, suggesting that linear interpolation between points provides representative data. This is true for temperature and humidity. It is a much poorer approximation for wind speed -- even if it were true at one instant, it would not be true a few minutes later. The lines joining data points show by means of arrows whether the balloon system was ascending or descending when those data were observed.

The dashed diagonal line is the dry adiabat or an isoline of potential temperature. The temperature lapse rate within a stratum of air which is well mixed in the vertical will be parallel to the adiabat. A stratum in which the temperature-versus-height curve is more nearly vertical than the adiabat or which slopes upward and to the right is hydrostatically stable, and air from one level does not mix readily with air above or below it. A stratum in which the temperature decreases more rapidly with increasing height than the adiabat is unstable. It is likely to overturn, and air from one level within such a stratum will mix readily with air from other levels. Such lapse rates are termed superadiabatic. They are frequently found near a warm earth's surface; they are not frequently found far from the surface except as thin transitory phenomena which result from dynamic instability. In general, motions of air except those very near the earth's surface are nearly adiabatic, and hence such motions are restricted to isentropic (θ) surfaces.

Figure II B-6 describes a transition from typical night flow to equally typical daytime flow. Two soundings, ascent and descent, at Station 020 in the canyon are shown in Figure II B-6a. The descent data are very nearly identical with the ascent, showing that the atmosphere up to 2000 ft. was in a quasi-steady state. The wind was flowing down the canyon at all levels up to 500 ft. In the stratum above 1000 ft. winds were from the north to northwest; these were characteristic of the free atmosphere above mountain-top levels. The zone from 500 to 1000 ft. was a transition zone between two very nearly opposing flows; winds in that zone were very light.

The temperature lapse rate was stable up to 1300 ft. during ascent and below 1100 ft. during descent. Above about 1200 ft. it was nearly adiabatic up to the top of the sounding during ascent. During descent a shallow stable stratum was evident at the top of the sounding, and the air was cooler in the layer from 1700 ft. to 1000 ft. than it had been a few minutes earlier during ascent. The change was less than two degrees, but it does illustrate quasi-steady state. The term "inversion" is often associated with the nighttime lapse rate. In these soundings the base of the nocturnal inversion is on the surface; the top is at the level where the temperature ceases to increase with increasing height.

Figure II B-6b are the soundings taken at Station 023 as soon as possible after the soundings at Station 020 shown in Figure II B-6a. It has many of the same characteristics as Figure II B-6a. The most fundamental difference is the wind direction in the stratum from the ground up to 700 ft. The winds are blowing down the slope toward the canyon and are nearly perpendicular to the winds in the canyon.

Figure II B-6 TETHERSONDE DIAGRAM

Figure II B-6a

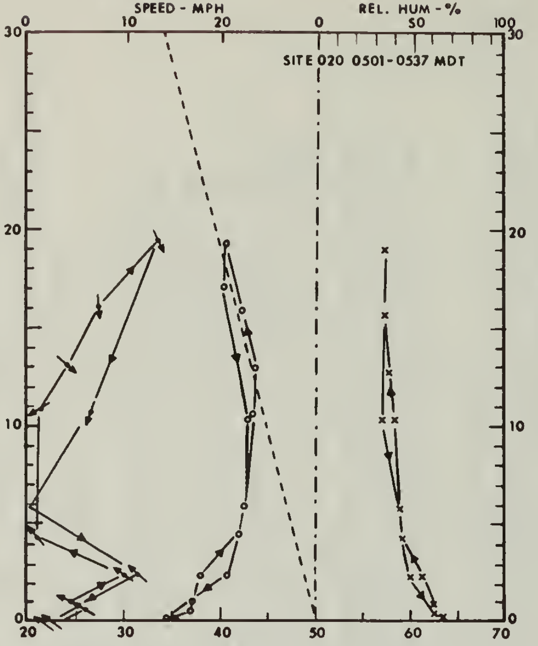


Figure II B-6c

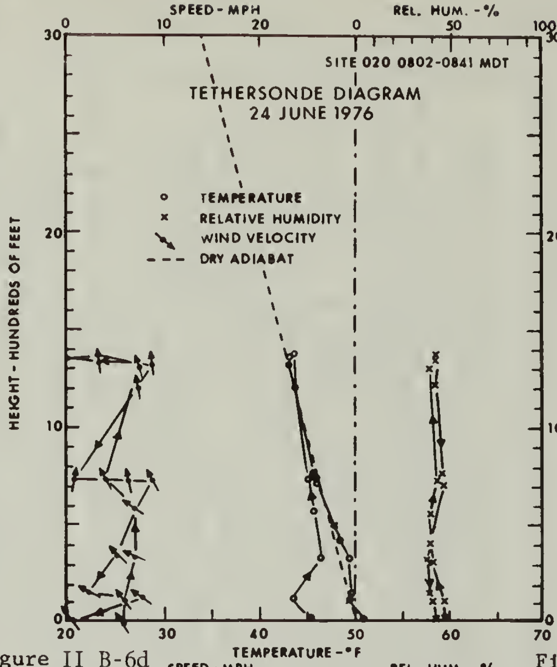


Figure II B-6c

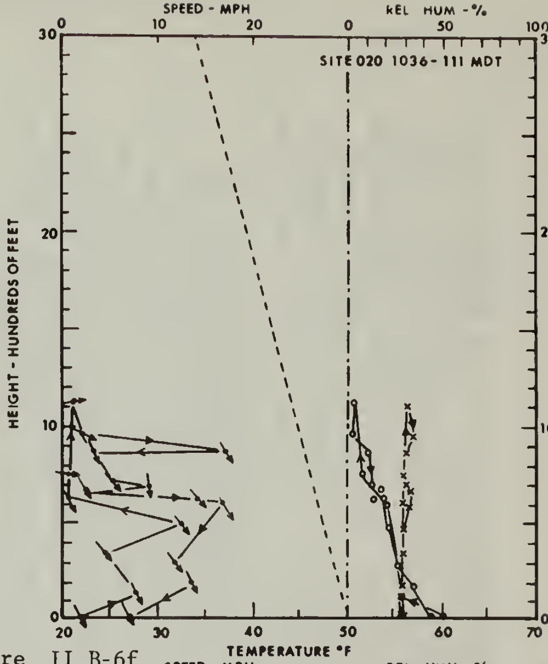


Figure II B-6b

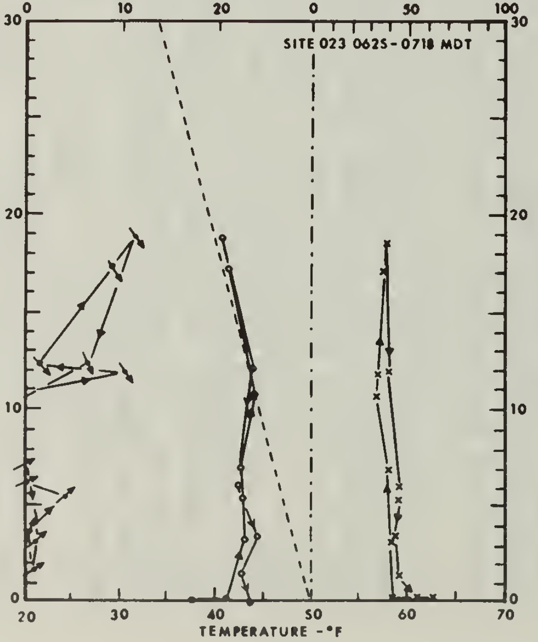


Figure II B-6d

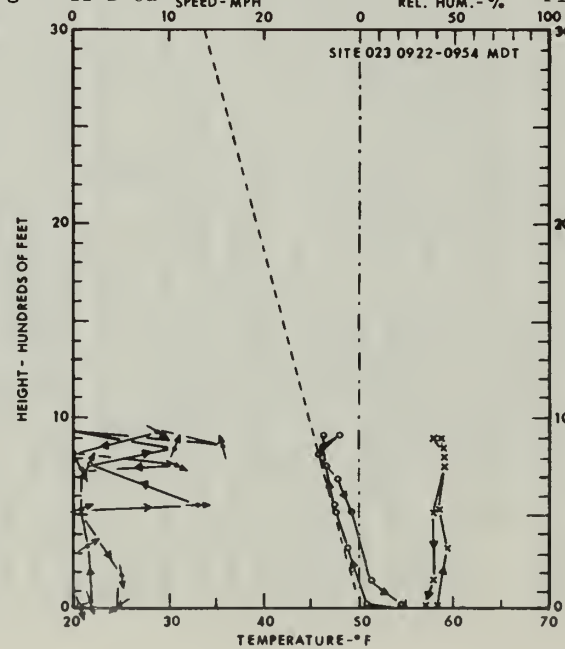
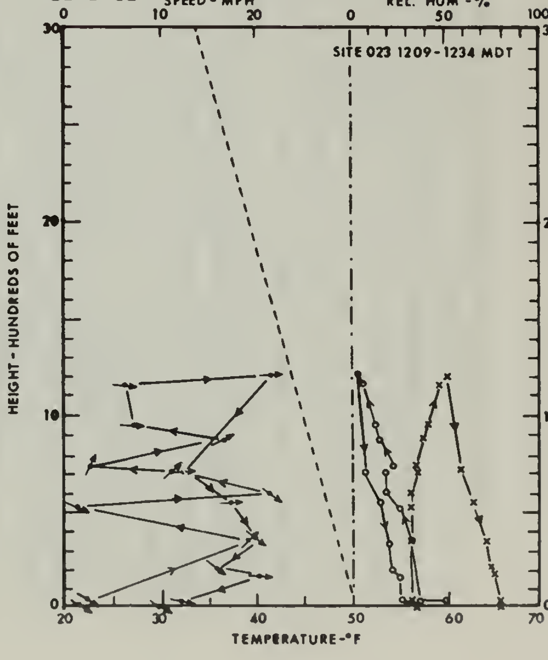


Figure II B-6f



Typical data recorded on the meteorological tower are shown in Table II B-31. At 0500 MST on 24 June, tower data indicate light winds from a generally south-to-southeasterly direction. Wind blowing over a rough surface characteristically changes direction in a clockwise fashion from the ground up to the top of the Ekman layer. Southerly winds at tower level are expected with southwesterly winds at a higher level. Temperature at the tower ranged from 37 °F to 39 °F. This was within one to two degrees of the temperature registered by the tethersonde. In view of the difference in time between tower and tethersonde observations and the fact that the tethersonde thermistor is shielded against radiation influences and ventilated, the differences are reasonable. This comparison with tower data serves two purposes. It shows that the two systems are capable of yielding comparable data, and it also shows that tower data cannot be extrapolated to higher levels. For example, there is no indication in the tower data of the calm stratum between 700 to 1100 ft., nor of the northwesterly winds above that. There is no indication of the depth of the stable layer which the tethersonde shows to be 1100 ft. deep.

A second pair of soundings taken at Station 020 is shown in Figure II B-6c. Winds are still blowing down the canyon at all levels up to 600 ft. Above that level, winds are more southerly and are blowing across the canyon from the south side. This is in contrast to nearly opposing winds at yet higher levels as shown by all soundings earlier in the morning. Sunrise occurred on the canyon floor about a half hour before this flight was started. By the end of the flight some cumulus of fair weather were forming to the southeast. The direct effect of the sun's radiation on the ground is clear in these soundings. A shallow, ground-based superadiabatic lapse rate had already formed when the ascent was started. By the time the descent was completed, heating at the ground and subsidence from above had created an adiabatic lapse rate in the entire 1300 ft. sounded. The cumulus of fair weather observed toward the southeast demonstrated that convective cells were starting to create small local circulations, subsequently superimposed on the circulations created by the terrain, which in turn are superimposed in the large-scale synoptic circulation. The southerly winds observed at the top of these soundings are probably caused by such convective activity.

Figures II B-6d, 6e, and 6f show continued warming throughout the morning until the descent on the last flight. They also show flow up the canyon at all levels sounded during the 0936-1011 flight at Station 020. This contrasts markedly with the flow down the canyon less than two hours earlier. At Station 023, the soundings show the nearly adiabatic lapse rates and gusty, shifting winds which typify convective activity. During the final flight at 1109-1134 the balloon encountered strong updrafts and downdrafts, but updrafts predominated. Note also that during the flight the air cooled nearly uniformly at all levels and the relative humidity rose rapidly. There were cumulus of fair weather clouds all around at this time.

Another form of graphical display shows many of the features previously discussed. Figure II B-7 is a vertical cross-section taken in a north-south direction through Stations 020 and 023. The terrain profile is

Table II B-31 TYPICAL TOWER METEOROLOGICAL DATA DURING TETHERSONDE TEST

		STATION 023																				STATION 020			
Date	Time* MST (Hrs)	Wind Speed (MPH)				Wind Direction (Deg.)				Std. Dev. in Wind Direction (Deg.)				Bar. Pr. (mb)	Air Temp (°F)				Temp. Diff. (°F)		Wind Speed (MPH)	Wind Dir. (Deg)	Std. Dev. Wind Dir. (Deg)	Air Temp (°F)
		8'	30'	100'	200'	8'	30'	100'	200'	8'	30'	100'	200'		8'	30'	100'	200'	100'-30'	200'-30'	30'	30'	30'	30'
6/19/76	0400	3	5	2	0	202	212	190	120	13	11	14	22	795	38	41	44	43	2.96	2.57	0	100	10	31
6/19	0500	2	1	1	2	165	180	52	80	12	16	3	8	795	41	41	43	44	1.66	3.06	0	110	15	30
6/19	0600	0	1	1	2	116	226	188	112	15	52	52	7	796	43	43	45	45	1.09	2.38	0	70	16	34
6/19	0700	1	1	2	1	56	56	77	100	30	26	30	21	796	48	48	47	45	-.72	-1.82	0	98	9	42
6/19	0800	3	4	3	2	48	32	26	348	41	18	33	32	796	54	54	52	51	-.84	-1.96	0	66	14	53
6/19	0900	3	5	5	5	102	301	321	358	180	20	16	108	796	59	60	59	57	-1.08	-2.19	0	346	40	61
6/19	1000	5	6	6	5	17	9	11	77	22	24	38	135	795	65	63	62	61	-1.29	-2.38	0	17	56	66
6/19	1100	6	7	8	7	348	336	338	101	104	90	76	76	795	67	66	64	63	-1.47	-2.45	0	66	60	68
6/19	1200	3	4	4	4	56	173	206	54	116	141	125	145	795	69	68	66	65	-1.50	-2.55	1	302	26	69
6/19	1300	3	4	5	5	169	209	273	286	165	154	154	21	795	71	71	69	68	-1.89	-2.98	0	230	106	72
6/20/76	0600	4	7	10	8	100	104	116	112	13	12	7	7	792	57	57	58	61	.98	4.47	8	130	7	50
6/20	0700	5	8	10	9	98	101	108	112	17	12	11	10	792	63	63	62	63	-.73	.27	5	130	7	59
6/20	0800	12	16	20	22	193	194	194	182	16	12	13	12	792	72	72	71	71	-.97	-1.64	0	92	20	71
6/20	0900	14	17	18	20	190	189	193	182	15	14	12	12	792	75	75	73	73	-1.52	-2.11	7	174	14	78
6/23/76	0300	1	4	4	4	240	228	248	252	13	13	11	6	789	42	42	42	41	.24	-.23	0	56	6	41
6/23	0400	1	2	2	0	142	156	157	206	11	13	12	12	789	41	43	43	41	-.34	-1.07	0	89	24	42
6/23	0500	0	1	1	1	88	121	213	247	7	25	4	7	790	44	42	43	42	.08	-.23	0	62	4	42
6/23	0600	2	5	1	1	224	222	280	299	12	11	13	9	790	43	44	44	43	.18	-.40	0	90	11	42
6/23	0700	1	2	2	1	14	30	48	2	28	26	25	33	790	44	45	44	43	-.86	-1.77	0	160	12	46
6/23	0800	3	4	5	5	356	11	2	298	100	135	120	22	790	50	48	47	46	-.98	-2.00	0	269	15	51
6/23	0900	5	7	9	9	286	321	335	324	93	18	13	12	791	49	49	48	47	-.84	-1.91	1	286	18	52
6/23	1000	3	4	5	5	88	77	38	18	56	97	22	20	790	53	52	51	49	-.81	-2.10	0	2	22	54
6/23	1100	8	10	11	10	206	204	206	197	15	10	13	11	790	54	52	51	50	-1.14	-2.15	2	291	14	56
6/24/76	0500	1	2	2	3	156	112	120	178	58	15	52	20	793	37	38	39	39	1.03	1.32	0	90	13	27
6/24	0600	2	3	3	4	106	108	125	150	16	8	12	11	793	41	39	40	40	1.12	2.04	0	85	26	30
6/24	0700	2	3	3	2	120	101	104	102	28	33	25	33	794	46	44	44	42	-.83	-2.02	3	124	7	39
6/24	0800	2	3	3	2	263	280	280	268	56	26	26	22	794	50	44	48	46	-1.00	-2.06	0	98	13	49
6/24	0900	2	4	4	3	354	352	10	11	94	66	26	30	794	52	51	50	48	-1.10	-2.69	0	46	18	53
6/24	1000	4	6	7	8	188	188	342	302	142	157	78	18	793	55	54	52	51	-1.33	-2.33	0	350	41	56
6/24	1100	7	9	9	8	149	333	338	8	152	32	35	131	793	58	56	54	53	-1.49	-2.52	6	312	26	58
6/24	1200	5	8	10	10	136	18	340	56	162	168	121	121	793	60	59	57	56	-1.53	-2.80	4	293	18	60
6/24	1300	6	8	9	9	260	256	259	240	42	40	34	38	792	62	61	58	57	-2.04	-3.07	6	289	18	62

* 5 minute values at the beginning of each hour

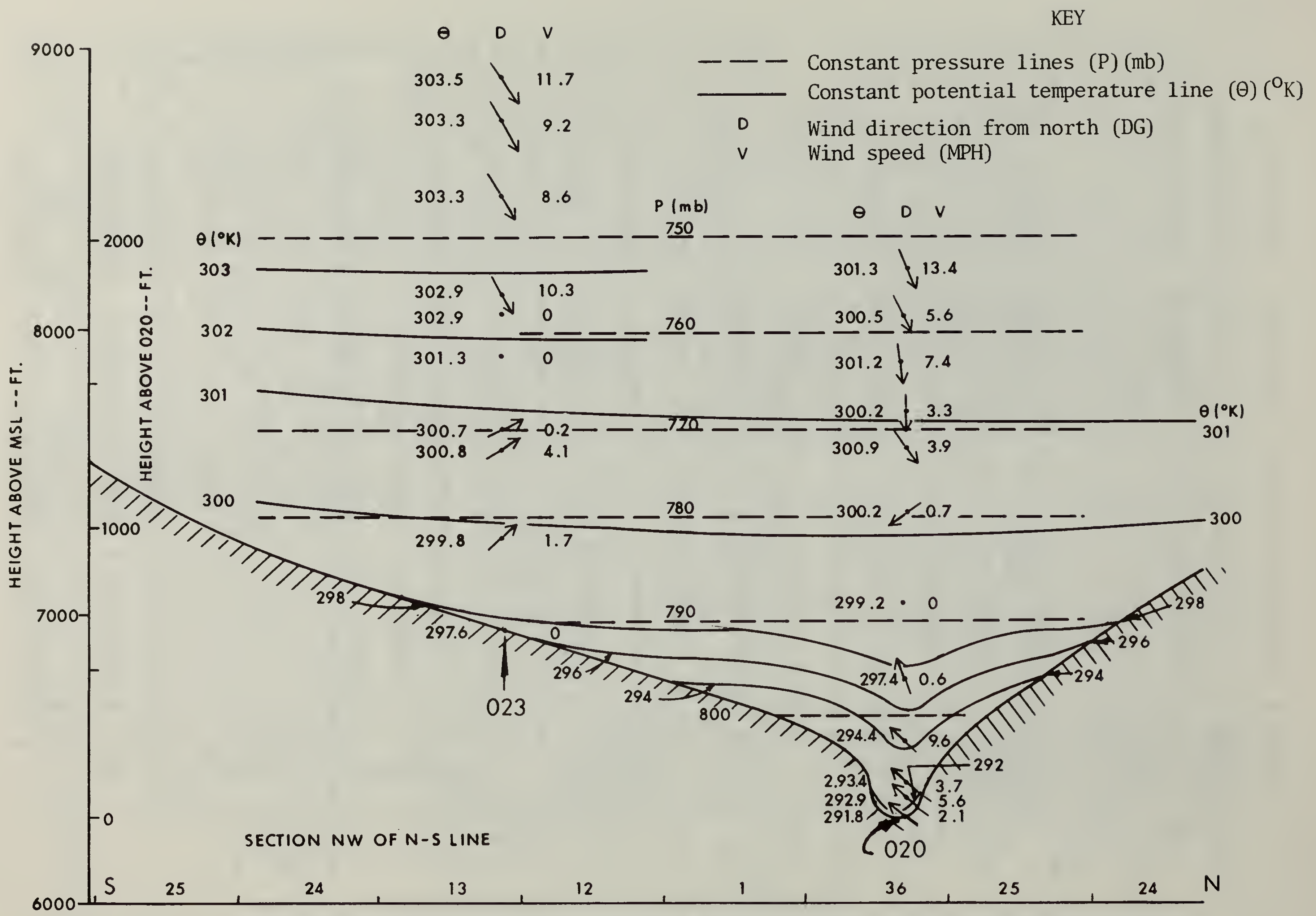


Figure II B-7 NORTH-SOUTH TETHERSONDE PROFILE THROUGH SITES 020 AND 023 ON 24 JUNE 1976,0400-0600 MST

highly smoothed, but it shows the general slope of the ground from both north and south, and it shows the much steeper walls of the canyon in which Piceance Creek flows. North is on the right so that the viewer is looking down the canyon. The horizontal distance unit along the bottom of the chart is one statute mile. The numbers of the sections immediately west of the north-south section line on which the profile is based are shown along the abscissa. Height in feet is given along the left side of the chart, using two scales. The outer scale is height above sea level; the inner scale is height above Station 020. Stations 020 and 023 are taken as 6325 ft. and 6960 ft., respectively, above mean sea level. The data plotted above the locations of the two sites are identified by symbols at the top of each data column. Potential temperature (θ) is in degrees Kelvin, wind speed (V) is in miles per hour and wind direction is indicated by an arrow pointing in the direction of the wind flow using a compass on which north is the top of the chart. When wind speed is zero, no direction arrow is given.

Isolines of θ are the solid lines. Isolines of pressure (isobars) are dashed lines. The θ lines are labeled along the margins of the chart. The isobars are labeled near the center.

In analyzing a chart of this type one takes advantage of knowledge of how meteorological variables are typically distributed above the earth's surface. For example, over such short distances as the horizontal dimension of this valley, pressure surfaces will be so nearly horizontal that it would be difficult to measure their slope even with the best of barometers. Therefore, isobars should be drawn as horizontal lines. Pressure was plotted at each height on a separate chart and the isobaric analysis was transferred to this chart. Hence pressure data are not shown above Stations 020 and 023.

Similarly, θ surfaces in the free atmosphere well above the mountains will be virtually horizontal unless disturbed by a frontal surface. Near the cold ground, however, θ surfaces over ground which does not have anomalous hot or cold spots will have a slope similar to the slope of the ground, but not as steep. Therefore, θ isolines will nearly parallel the surface where they approach the surface. They will depart slowly from the surface in the downhill direction. Over a ridge they should be horizontal, and at great heights over a valley they should be horizontal. In general in the absence of some sort of disturbance, the further from the ground a θ isoline is found the more nearly horizontal it should be.

With these guidelines in mind, the tethersonde data from the two sites were analyzed to yield the pattern presented in Figure II B-7. Several interesting features can be identified on the chart. First, the data show that the θ lines do slope downward in the lower strata from Station 023 to 020. Since the winds in these strata at Station 023 are toward Piceance Creek, air (and any pollutants it may contain) will descend as it moved northward unless it gains heat. If heat is gained, the air mass can cross potential surfaces toward greater values, but, since there is not a heat source to warm the air, it will descend. The figure also shows that the valley influence is being clearly manifested at Station 020 up to the 300 $^{\circ}$K isotherm. At Station 023 the valley influence is being felt at least as high as the 300.7 ^{o}K isotherm. A strong θ inversion extends as high as 303 ^{o}K isotherm at Station 023 and the 301 ^{o}K isotherm at 020. It is apparent that a significant change in θ occurred at the highest levels reached at Station 020 during the time between soundings, since gradients of over 2 ^{o}K in the short distance between sites are not likely in the free atmosphere. There is not enough information at higher levels to permit an assessment of what occurred. Most important, whatever the cause, it does not appear to have seriously affected the flow or the distribution of potential temperature in the valley. This attests to the ability of the valley to influence local flow.

Regarding interpretation of the acoustic sounder records (signatures) for the period concurrent with the tethersonde, four typical record reproductions are shown as Figures II B-8 to II B-11 for periods of 19-20 June and 23-24 June. Letters on the records correspond to specifics detailed in the two reports appearing in Quarterly Data Report #8. (See footnote P. 53).

In general, to have a return from a particular stratum which is strong enough to register on the sounder record, there must exist a lapse rate which is significantly different from adiabatic; this stratum also must be a source of turbulence. Thus a stratum in which there is an inversion may or may not provide a return; it will return only if the air in the stratum is turbulent. A superadiabatic stratum, on the other hand, is likely to yield a good sounder signal because it is not adiabatic and it contains within it the mechanism to generate turbulance.

In Piceance Creek two very distinct types of record were observed during the period covered by this study. On almost every afternoon the sounder record showed spikes with their base on the ground and their tips extending to heights which varied rapidly with time but rarely exceeded 1300 ft. (see Figure II B-10). It occurs when the stratum immediately adjacent to the earth's surface is heated by the surface so that its lapse rate is superadiabatic. That stratum has the ingredients required to produce turbulence and to create temperature differences between turbulent elements which will scatter sonic energy. The spikes that are seen on the record are associated with thermal plumes formed in the unstable stratum. Turbulent elements are formed around the periphery of the rising plumes; some are advected upward with the rising air; others remain behind. Since temperature inhomogeneities can be formed only in the superadiabatic stratum, a darker, broader return exists near the surface than that seen at higher levels where only a few of the elements created about the periphery of the base of the plume can reach.

Good vertical mixing is associated with a sounder return in which these vertical spikes exist. It is not clear how high this mixing extends, however. It must extend above the upper limits of the spikes, and unless a horizontal return is observed at some higher level on the chart, it is generally safe to assume that the clear area above the spike is indicative of an adiabatic lapse rate and hence of a mixed atmosphere.

The second type of record occurred typically at night (Figure II B-8).

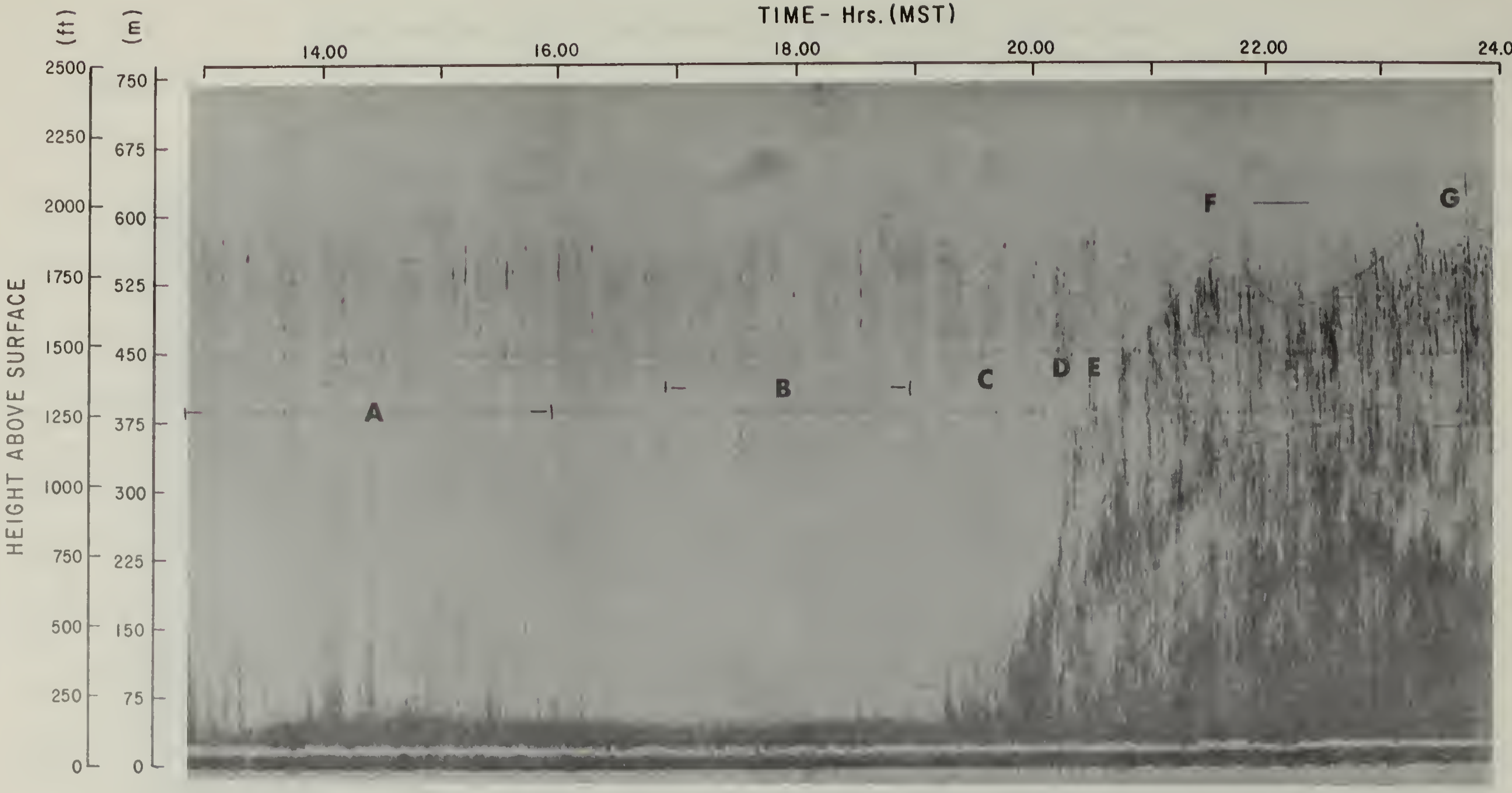


Figure II B-8. Acoustic echo sounder record from noon to midnight on 19 June 1976 at Site 020. Letters on the overlay correspond to references made in the text (see text). Alternating dark and light vertical traces are caused by line voltage fluctuations.

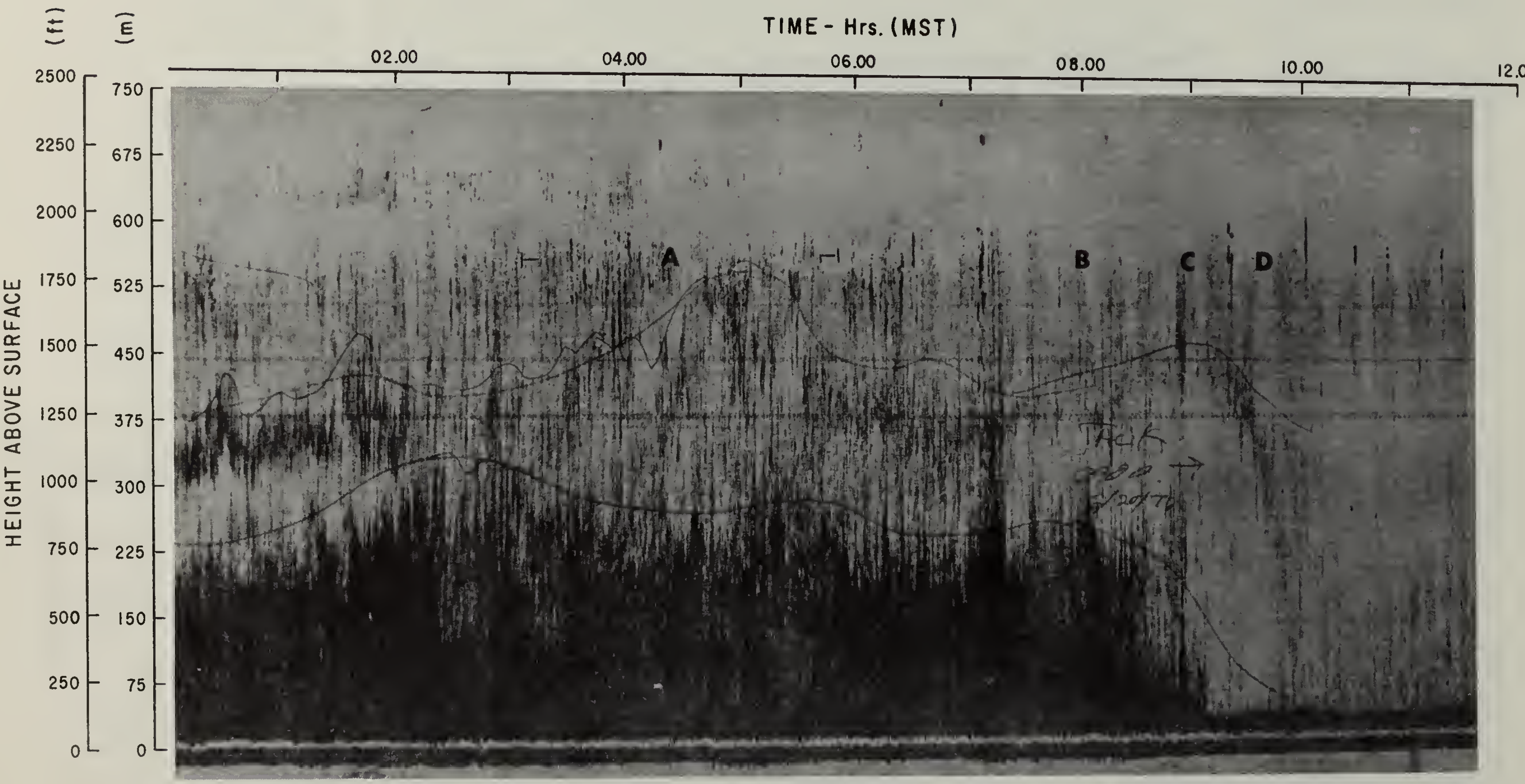


Figure II B-9 Acoustic echo sounder record from 0000 to 1200 hours MST on 20 June 1976 at Site 020. Letters on the overlay correspond to references made in the text (see text). Alternating dark and light vertical traces are caused by line voltage fluctuations.

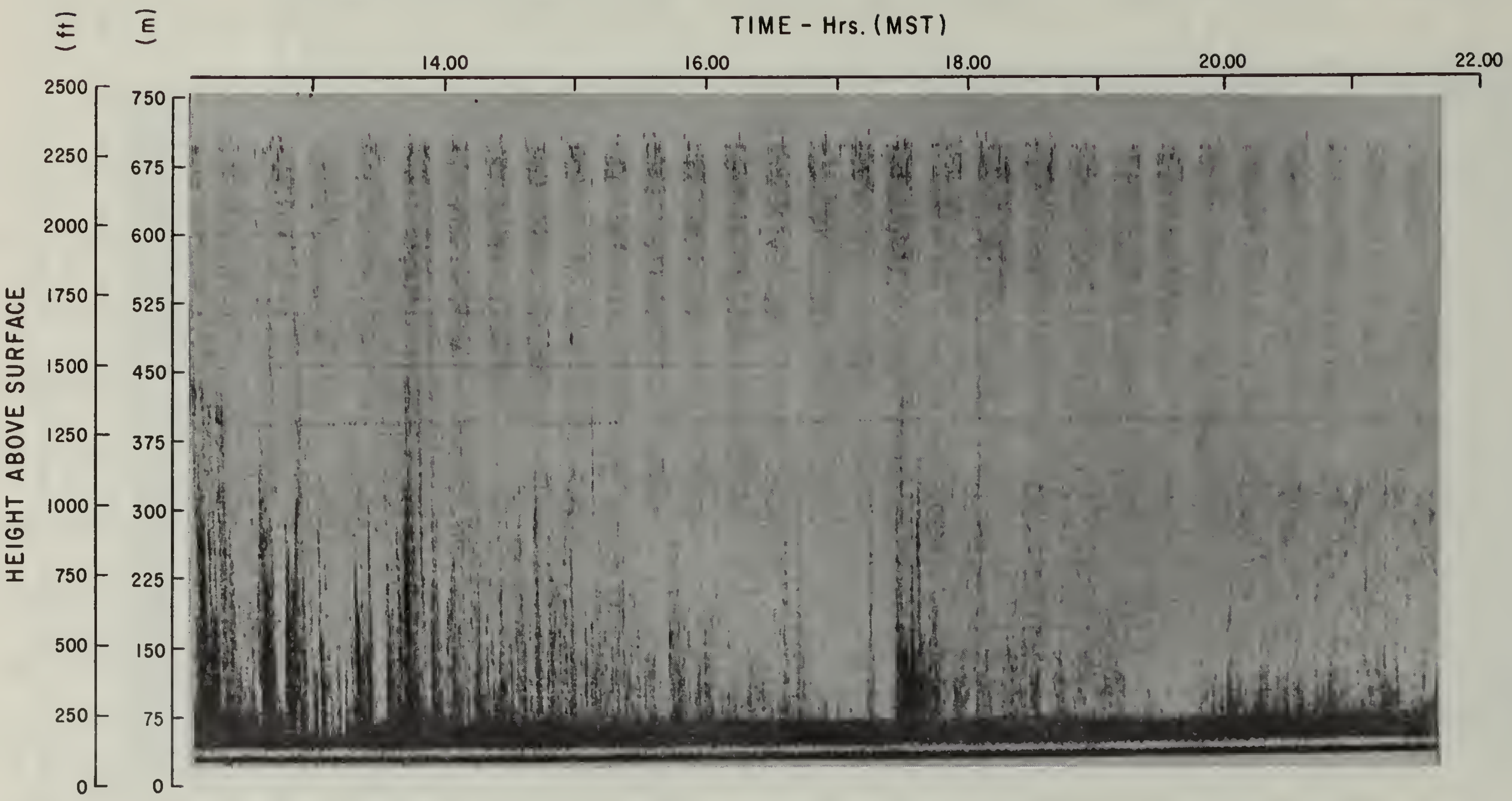


Figure II B-10 Acoustic echo sounder record from noon to 2200 hours MST on 23 June 1976 at Site 020. Alternating dark and light vertical bands are caused by voltage fluctuations.

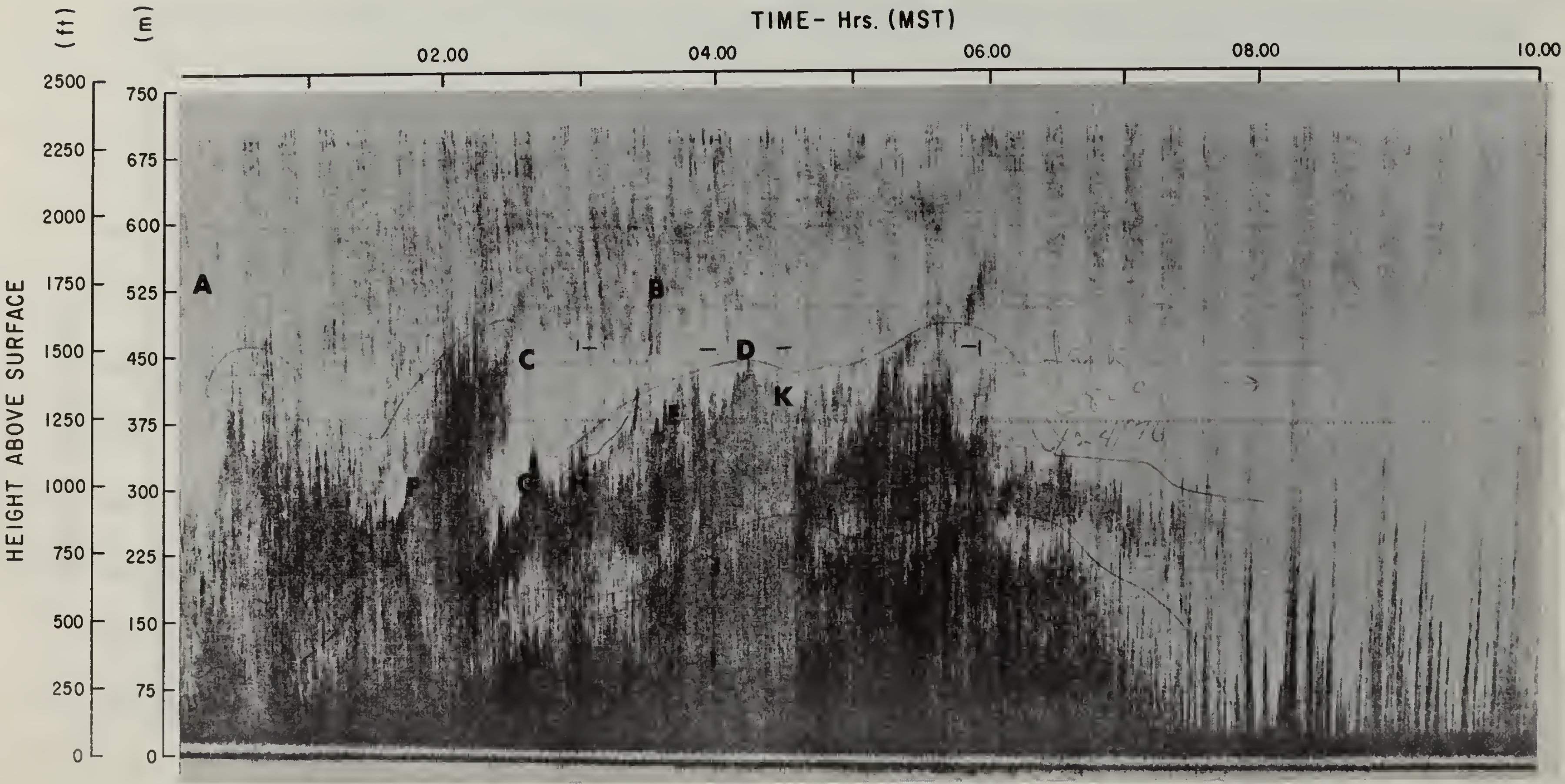


Figure II B-11 Acoustic echo sounder record for the period from 0000 to 1000 hours MST, 24 June 1976 at Site 020. Reference to the letters on the figure are made in the text (see text). Alternating dark and light vertical bands are caused by fluctuations in line voltage.

It characteristically shows returns which suggest quasi-horizontal stratification of the atmosphere. There are usually strong returns from near the surface. Above the surface, one or more dark bands may appear, separated by lighter bands. These bands may be nearly horizontal at times, but they are more likely to slope upward or downward, or perhaps to undulate.

The interpretation of these returns is not as simple as interpretation of mid-day returns. The dark bands must be associated with turbulence within a stratum which is not adiabatic (probably a potential temperature inversion since a superadiabatic lapse rate is not likely). The light bands may be indicative of either an adiabatic lapse rate or of a lack of turbulence in a stable layer or both. The tethersonde data show that adiabatic lapse rates at the level of the light bands are infrequent at night; therefore the air in these strata is evidently not as turbulent as in the strata which yield greater sonic scattering.

It is easy to postulate the source of the turbulent energy in two of the layers at night. Air adjacent to the slopes is cooler than that further away in the valley centers. These cooler temperatures create a pressure gradient which in turn drives the winds. At the surface, as the air flows downhill, it further cools as it goes. As it flows over the rough terrain, turbulence is created. The turbulent energy derives from the kinetic energy of the flowing air which in turn is maintained by the P-θ (pressure-potential temperature) solenoids which result from the cooling of the air adjacent to the sloping surface. Thus despite the great surface friction within the very stable air, flow is maintained, and turbulence is generated continuously. This is observed on the acoustic sounder record as a dark region at the bottom of the chart.

This region varies in depth in a way which is partially predictable. When the ground starts to cool and create a surface θ inversion in the evening, the down-canyon flow begins by the mechanism described above. Then the stable, turbulent surface layer is shallow. With continued cooling, this layer becomes deeper and the speed of flow increases. Consequently, the sounder return near the bottom of the chart grows upward in the evening (Figure II B-8). In the morning when the ground starts to warm, the cold air supply is cut off. That which is in the valley continues to drain away, but its depth and speed decrease. The record should therefore show a return near the bottom which is decreasing in height during the hours around sunrise (Figure II B-9). This nocturnal waxing and waning is normally seen on any night when the skies are clear enough to permit good radiative cooling of the ground. On a night when low clouds are present all night, neither the inversion nor down-slope wind should be expected; hence this type of return should not occur.

This lowest band suggests also that a very transitory phenomenon near the ground should be observed just after sunrise. As the surface starts to heat, a shallow layer of air adjacent to the ground starts to heat and soon becomes superadiabatic. This is the mechanism which cuts off the supply of cold air, and it should be visible on the record as surface-based spikes which grow in height with time, eroding the cold, stable air from the bottom. Concurrently, the top is lowering because the supply of cold air is terminated while flow continues toward lower terrain. Therefore, the sounder return from the cold, stable air should take the form of a wedge with its point a short distance off the surface.

The height from which sounder returns are recorded in the surface, cold air stratum should be a function of the depth of the stable air, its speed over the rough surface, and the roughness of the surface. It is quite possible that the cold, stable air may become too deep for the effect of surface friction to be felt throughout its depth. It is also possible that the cold air may be perturbed at its upper surface by the flow of the air high above the ground. When the katabatic flow is shallow (e.g. in the early evening), there may be no way to differentiate the cause of turbulence in that flow. Later, however, the cold, stable air may become so deep that disturbances from above do not cause turbulent mixing in the strata disturbed from below. Then a stratum could exist within the cold air in which turbulence is not strong enough to yield a return. Thus it is readily conceivable that at least two bands of strong return may exist, separated by a band of weak return (Figure II B-11).

Inversion characteristics for acoustic sounders at Stations 020, 021, and 023 from times of installation are shown on Tables II B-32 to II B-34 as monthly values for number and height of inversions; Table II B-35 is a monthly frequency analysis for inversion duration at Station 023; the sloping line shows the approximate mean duration by month. It is of interest to note that five inversions of duration longer than 36 hours have been recorded at Station 023, two in December 1974, one in January 1975, one in December 1975, and one in January 1976. For the companion period of overlapping measurements for Stations 023 and 021, since their installation (November 1975 - June 1976) they compare as follows:

	Station 021	Station 023
Total number of days of measurement ("up" time)	164	180
Total number of days with inversions	147	154
Total number of days with no inversions	17	26
Percent of days of measurement with inversions	89.6	85.6
Total number of inversions	295	190
Mean inversion duration (Hrs.)	9.4	10.3
Mean average inversion height (top) above surface (Ft.)	708	536
Mean average inversion height (top) above MSL (Ft.)	6908	7506

III B-4 Visibility Study

The camera site and views for this study were previously shown as Figure II B-11 of Summary Report #6. Daily mean, monthly mean, and seasonal mean visual-ranges are reported by each of four views and for the composite of all views in this study.

Table II B-32 Means and Standard Deviations of Inversion Durations and Maximum, Minimum, and Average Inversion Heights by Month as Obtained from Acoustic Sounder, Station 023

Month	Number of Days of Measurement	Number of Inversions Recorded	Inversion Duration (hrs)		Maximum Inversion Heights (ft)		Minimum Inversion Heights (ft)		Average Inversion Heights (ft)	
			Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Dec. '74	25	19	16	11	1207	461	421	277	796	332
Jan. '75	30	24	14	7	1417	354	604	366	1019	386
Feb.	28	25	12	4	1467	358	383	157	925	239
Mar.	27	28	6	3	1383	485	693	371	1028	442
Apr.	21	28	4	3	932	370	468	223	686	266
May	29	26	5	3	884	347	457	192	673	263
June	0		(no measurements were made in June)							
July	15	33	3	2	1760	709	764	400	1202	483
Aug.	11	11	6	4	1414	508	555	369	945	436
Sept.	29	29	8	5	828	256	244	119	500	161
Oct.	20	18	11	4	623	200	197	76	414	152
Nov.	22	20	10	7	620	320	204	205	399	273
Dec.	30	38	13	8	917	514	319	225	596	335
Jan. '76	24	25	13	9	806	405	266	254	521	345
Feb.	28	22	12	5	994	654	290	224	607	348
Mar.	31	30	10	4	657	708	217	127	423	161
Apr.	5	8	7	3	607	202	189	39	376	76
May	22	28	9	3	1188	444	364	246	760	335
June	18	19	8	3	832	274	266	96	522	175
July[1]	-	-	-	-	-	-	-	-	-	-
August	21	22	7	3	996	252	472	205	735	203

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[1] No measurements were made in July

Table II B-33

MEANS AND STANDARD DEVIATIONS OF INVERSION DURATIONS AND MAXIMUM, MINIMUM AND AVERAGE INVERSION HEIGHTS BY MONTH AS OBTAINED FROM ACOUSTIC SOUNDER

Station 021

Month	Number of Days Measurement	Number of Inversions Recorded	Inversion Duration (Hrs)		Maximum Inversion Heights (Ft)		Minimum Inversion Heights (Ft)		Average Inversion Heights (Ft)	
			Mean	Std Dev	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
Oct. '75	0									
Nov. '75	23	35	14	6	780	292	266	175	574	217
Dec. '75	10	18	11	5	779	216	317	186	553	175
Jan. '76	18	32	10	5	1145	345	497	238	849	270
Feb. '76	24	34	14	6	726	475	199	200	509	321
Mar. '76	30	46	12	4	706	353	160	117	482	256
Apr. '76	30	63	0	4	968	365	382	189	707	272
May '76	19	49	7	3	1146	472	536	258	903	402
June '76[1]	10	18	7	3	1362	535	647	344	1083	484

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[1] Through June 13, 1976 only.

Table II B- 34

MEANS AND STANDARD DEVIATIONS OF INVERSION DURATIONS AND MAXIMUM, MINIMUM AND AVERAGE INVERSION HEIGHTS BY MONTH AS OBTAINED FROM ACOUSTIC SOUNDER

Station 020

Month	Number of Days Measurement	Number of Inversions Recorded	Inversion Duration (Hrs)		Maximum Inversion Heights (Ft)		Minimum Inversion Heights (Ft)		Average Inversion Heights (Ft)	
			Mean	Std Dev	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
June[1]	13	26	8	3	1412	342	531	269	1077	339
July	14	31	8	3	1318	359	563	240	1031	309
August	2	2	11	1	1206	271	541	49	867	34

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[1] From June 13, 1976 only.

Table II B-35

FREQUENCY ANALYSIS OF AIR TEMPERATURE INVERSION DURATIONS
ACOUSTIC SOUNDER STATION 023

Inversion Duration (Hrs.)	Dec '74	Jan '75	Feb	Mar	Apr	May	June^1	July^2	Aug^3	Sept	Oct	Nov	Dec	Jan '76	Feb^4	Mar	Apr	May	June	July^5	Aug	Sept	Oct	Totals	Percent of Grand Total
0-3.9	0	1	2	9	14	8	-	25	6	9	1	4	2	2	2	9	14	8	2	-	1			119	25.9
4-6.9	5	3	2	12	9	10	-	7	1	4	3	5	10	3	2	9	9	10	1	-	10			115	25.1
7-9.9	3	2	5	1	3	7	-	1	1	2	3	2	7	4	2	4	2	8	4	-	5			66	14.4
10-12.9	0	2	6	5	2	1	-	0	2	6	5	2	3	5	2	5	2	1	11	-	4			61	13.3
13.15.9	1 *	3	6	1	0	0	-	0	1	7	5	5	4	3	4	2	0	0	1	-	2			43	9.4
16.18.9	5	7	1	0	0	0	-	0	0	1	1	1	6	3	2	0	0	0	0	-	0			27	5.9
19-21.9	1	5	1	0	0	0	-	0	0	0	0	0	3	2	1	0	0	0	0	-	0			13	2.8
22-24.9	0	0	1	0	0	0	-	0	0	0	0	0	1	1	0	0	0	0	0	-	0			3	0.7
25-30.9	2	0	0	0	0	0	-	0	0	0	0	0	0	1	0	0	0	0	0	-	0			3	0.7
31-35.9	0	0	1	0	0	0	-	0	0	0	0	1	1	0	0	0	0	0	0	-	0			3	0.7
36- <	2	1	0	0	0	0	-	0	0	0	0	0	1	1	0	0	0	0	0	-	0			5	1.1
																						Grand Total =		458	100.0

[1] No measurements in June

[2] July 17 - July 31, 1975 only

[3] August 1 - August 10, 1975 and August 29 - August 31, 1975 only

[4] February 1 - 19, 1976 only

[5] No measurements were made in July

*Line of monthly mean duration (Hrs.)

Daily mean visual-ranges did not exhibit large fluctuations during the summer quarter; variations in the mean visual-range of consecutive days of photography averaged 18 miles and were generally less than 30 miles. The single exception occurred during the last week in August when the daily mean visual-range increased from 69 to 109 miles within a six day period. The smallest variations occurred from late June to mid July and during mid August when the daily mean visual-ranges fluctuated less than 10 miles and on several occasions varied by only one or two miles. Mean visual-ranges generally ranged from the low sixties to near one hundred miles, although one daily mean visual-range near 110 miles was recorded. No days occurred in which visual-range measurements could not be made in at least one view during each hour of photography.

The variation in the visual-range among the four views was usually less during periods of low daily mean visual-ranges than during days of high mean visual-ranges. Between June 30 and July 18, for example, when the daily mean visual-range fluctuated between 62 miles and 71 miles, the maximum variation among the views was 13 miles; between August 5 and August 17, when the daily mean visual-range fluctuated between 94 miles and 98 miles, the maximum difference was 36 miles. The maximum variation among the views during the entire quarter was also 36 miles, although the average range of values was 16 miles.

Monthly mean visual-range was 71 miles in June, 72 miles in July, 94 miles in August, and 74 miles in September. Maximum values exceeded 146 miles; minimums were below 36. The general characteristics of each of the summer months along with previous data are listed in Table II B-36. The monthly composite distribution of visual-range is shown in the data report.

During the summer quarter, visual-ranges were generally high; ninety-five percent of the visual-range measurements were greater than 51 miles; fifty percent were greater than 79 miles. Pertinent statistics for each view and all views combined during the summer quarter (and previous quarters) are listed in Table II B-37. Maximum visual-ranges obtained during this period varied slightly among the views; maximum values of 138, 128, 117, and 147 miles were recorded for Views I to IV respectively. Minimum visual-ranges from 45 to 57 miles were recorded. The mean visual-range in View II was the lowest. The mean visual ranges for Views I, II, III, and IV were 82, 72, 76, and 85 miles, respectively.

For purposes of describing the general state of visibility independent of direction, a composite distribution of all visual-range measurements during the summer quarter was made. This distribution is illustrated in Figure II B-12. Visual-ranges obtained during this period occurred most frequently between 70 and 80 miles.

To distinguish that mean value for all views during a season from the mean visual-range for an individual view, the term generalized visibility has been chosen to represent the composite mean visual-range. The range is reserved for a single path or view. The generalized visibility in the Piceance Creek Basin area during the summer quarter was 79 miles.

Table II B-36
VISUAL RANGE (MILES) STATISTICS FOR THE COMBINATION OF ALL VIEWS FOR EACH MONTH OF MONITORING
PICEANCE CREEK BASIN, COLORADO
1975-1976

MONTH	MEAN	MAXIMUM	MINIMUM	STANDARD DEVIATION
September	77	131	42	24.0
October	89	144	44	24.6
November	99	149	24	29.0
December	86	147	17	31.1
January	72	137	27	29.2
February	84	149	25	28.2
March	70	116	27	19.2
April	67	138	14	27.7
May	70	124	27	16.7
June	71	117	45	14.8
July	72	120	45	15.9
August	94	147	45	20.1
September	74	113	35	17.9

Table II B-37
VISUAL RANGE SEASONAL SUMMARY (MILES)
PICEANCE CREEK BASIN, COLORADO

FALL, 1975

VIEW	MEAN	MAXIMUM	MINIMUM	5 PERCENTILE*	STANDARD DEVIATION
I	93	149	37	49	27.8
II	77	142	42	43	23.6
III	92	146	24	46	27.4
IV	101	148	48	52	25.8
Composite	91	149	24	45	27.3

WINTER, 1975-76

VIEW	MEAN	MAXIMUM	MINIMUM	5 PERCENTILE*	STANDARD DEVIATION
I	87	143	31	41	23.9
II	66	115	31	41	19.2
III	83	149	17	30	34.1
IV	86	147	22	26	35.4
Composite	80	149	17	33	30.0

SPRING, 1976

VIEW	MEAN	MAXIMUM	MINIMUM	5 PERCENTILE*	STANDARD DEVIATION
I	74	118	39	50	18.9
II	63	113	32	40	16.5
III	67	118	14	25	22.3
IV	73	138	27	38	24.5
Composite	69	138	14	39	21.1

SUMMER, 1976

VIEW	MEAN	MAXIMUM	MINIMUM	5 PERCENTILE*	STANDARD DEVIATION
I	82	138	57	52	20.0
II	72	128	45	46	16.6
III	76	117	49	51	17.2
IV	85	147	50	61	23.3
Composite	79	147	45	51	20.0

* 5 percentile is that value above which occurs 95% of the measurements.

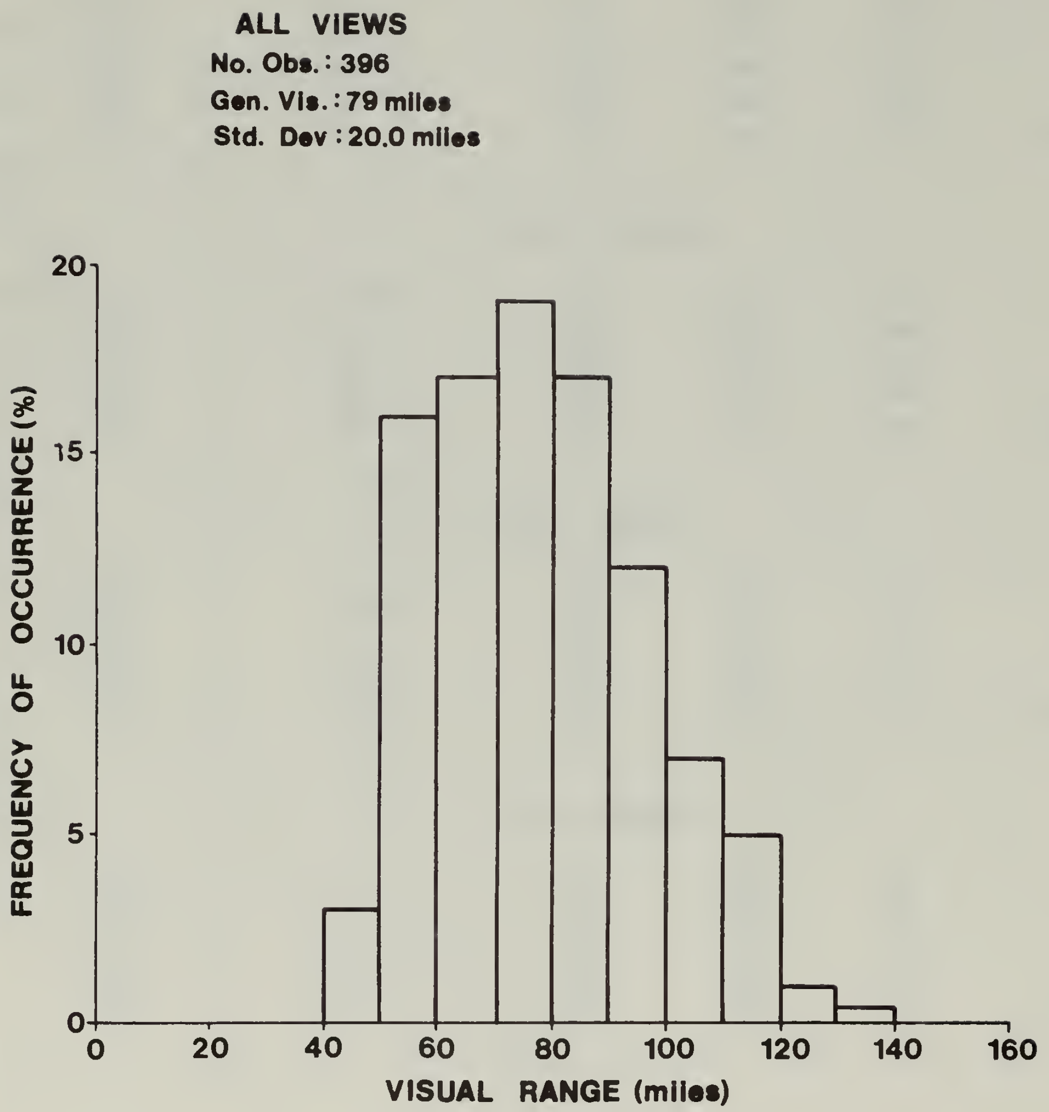

Figure II B-12

COMPOSITE VISUAL RANGE DISTRIBUTION
PICEANCE CREEK BASIN, COLORADO
SUMMER, 1976

This value can be compared to the results of a similar study conducted over an eight month period (September 1974 - April 1975) at Grand Valley, Colorado (Dames & Moore, 1975). The generalized visibility during that study was 86 miles.

To describe hourly trends, mean hourly visual-ranges for each view and for all views combined (Figure II B-13) have been presented to facilitate comparison of the individual trends. The composite trend, shown in Figure II B-13, exhibits a slight decrease in visual-range over the course of a day.

II B-5 Noise

Monthly noise measurements are made at the 14 locations cited on Figure II C-7 of Summary Report #4 utilizing a General Radio 1565-B sound-level meter. Data for this reporting period cover the June-August months of 1976 and are contained in Quarterly Data Report #8. Average values at A-weighting are up to 79 db along Piceance Creek road in the presence of passing vehicles and 44-63 db at the on-tract sites.

II B-6 Atmospheric Diffusion Studies

As part of the input required for atmospheric diffusion models, wind persistence at specified atmospheric stability has been investigated over the first year of baseline. Monthly wind persistence charts for all stability classes, in format similar to those reported in the previous summary report, have now been completed.

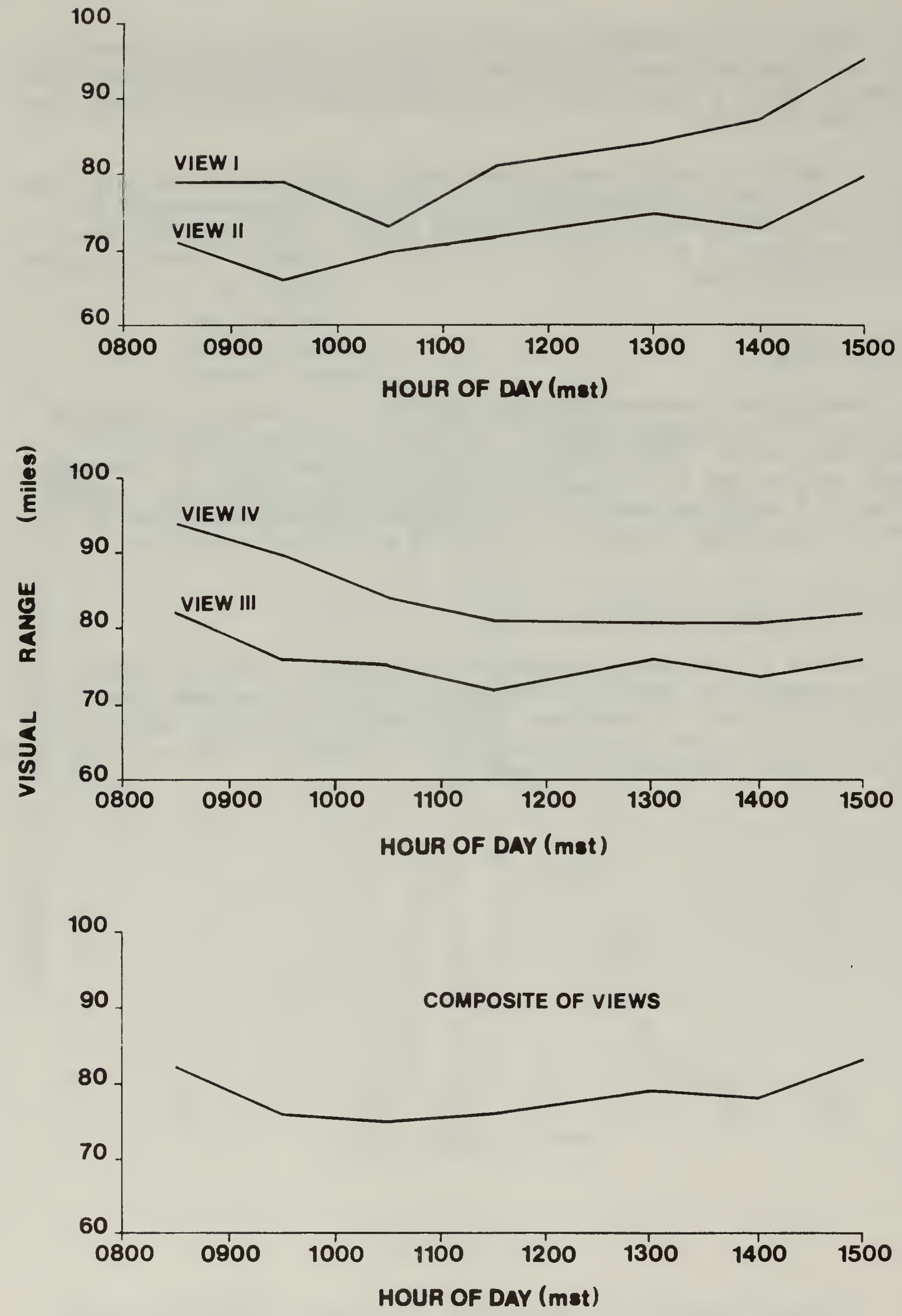

Figure II B-13

VARIATION IN THE MEAN HOURLY VISUAL RANGE
PICEANCE CREEK BASIN, COLORADO
SUMMER, 1976

II C BIOLOGY

II C-1 Terrestrial Wildlife Studies

Big Game

Mule Deer Habitat Use

Shrub production and utilization: Measurements of new shoot lengths on key browse plants were initiated this season to augment results obtained by the ocular method. Three browse species were chosen for measurement--antelope bitterbrush, mountain mahogany, and serviceberry. An estimate of 1975 shrub production was obtained by measuring the lengths of new shoots on plants within permanent exclosures located in pinyon-juniper and chained rangeland habitat types. The 1975-76 utilization of this component of total shrub production was estimated by measuring the remainder of the new shoots in spring. This was accomplished before new growth began, but after the wintering deer had moved to higher summer range. While these data have not been completely analyzed at this time, the sample sizes in all but one case are adequate to estimate means within a sampling error of ±20% at a 90% level of confidence.

Mule Deer Mortality Studies

The deer mortality field investigations of last year (Quarterly Report #4) recorded both the number of deer carcasses on Tract C-b that represented the then current winter kill (1974-75 deaths) and all older carcasses as well. During May and June of this year, only current winter kills (1975-76 deaths) were recorded. This year's investigations (Table II C-1) were conducted using the same methods previously employed (Quarterly Report #4 and Annual Summary and Trends Report).

Of the 28 deer carcasses found this past season, 23 were fawns and 5 were adults. These results are very similar to the results of last year, which reported 29 deaths; 24 were fawns and 5 were adults. These data do not include road kill or mortalities from hunting.

As previously described (Quarterly Report #4), the emphasis of the deer mortality study is on evaluation of the relative importance of the various habitat types to wintering deer. Estimates of total mortality within the Tract boundary are a secondary concern. The frequency of occurrence of deer carcasses in the permanent plots (Table II C-1) shows essentially the same pattern as last year. Namely, on a per area basis most of the winter kill occurs in the lateral draws. The importance of lateral draws to wintering deer appears to relate to the food and protection provided in the draws during inclement winter weather.

A statistical analysis of the data presented in Table II C-1 was performed to evaluate differences among the five habitat types. When subjected to a log-likelihood G test for goodness of fit (Zar 1974), the hypothesis that carcasses occur randomly throughout the five habitat

Table II C-1 DISTRIBUTION OF 1975-76 DEER MORTALITIES ON TRACT C-b.

Habitat type	Number of carcasses found	Number of carcasses expected if randomly distributed	Number of acres sampled
Pinyon-juniper woodland	3	7.5	79
Chained rangeland	1	7.5	79
Bottomland sagebrush	2	3.8	40
Lower agricultural meadows and adjacent bottomland sagebrush	14	7.5	79
Lateral draws	8	1.7	18
TOTALS	28		295 (119.25/ha)

types was rejected ($p \ll .001$). Subdividing the G test by habitat type indicated random occurrence throughout the pinyon-juniper, chained, and bottomland sagebrush habitats ($0.25 < p < 0.5$). Significantly more carcasses were found in the combined lateral draw and agricultural/sagebrush habitats ($p \ll .001$), with significantly more carcasses in the lateral draws than in the agricultural/sagebrush habitats ($.025 < p < .05$). The last two tests were corrected for continuity.

Medium-sized Mammals

The bi-monthly track counts for medium-sized mammals (and deer) were conducted during July. Results are shown in Table II C-2. The absence of deer, as indicated by these data, is to be expected since by mid-summer virtually all of the local herd that winter in the Tract area are on higher winter range. Cottontail tracks occurred in all habitats sampled, but the results shown do not suggest large populations.

Reference

Zar, J. H. 1974. Biostatistical Analysis. Prentice-Hall, Inc. Englewood Cliffs, N. J. pp. 620.

Small Mammals

During the May-July 1976 trapping period, nine species of small mammals were live trapped. This total included nine species on Grid 1, six species on Grid 2, and nine species from the satellite grids.

Density estimates were generally high throughout the May-August period for most species. Large litters in May-June and favorable survival rates for juveniles and subadults were responsible for the high densities. This first peak of reproductive activity (May-June) was not followed by a second peak in late summer.

The frequency of food items in the diets of the deer mouse and least chipmunk were determined. Both species relied heavily on vegetation in early summer but included a larger percentage of arthropods during late summer. A mid-June freeze, which damaged shrubs and grasses, may have contributed to the change in diet.

Arthropods

Arthropods representing 53 families were identified from collections on Tract C-b during May-June 1976. Analysis of data from pit can traps indicates that the chained pinyon-juniper and pinyon-juniper vegetation support equally diverse arthropod faunal assemblages. The relative abundance of certain arthropod species did vary with the species of shrubs sampled by sweep netting. The Miradae and Cicadellidae were most abundant on big sagebrush while the Psyllidae were most abundant on mountain mahogany.

Table II C-2 PERCENT FREQUENCY* OF TRACKS FROM COUNTS CONDUCTED ON JULY 14, 1976

Habitat type	No. of quadrats	Deer	Coyote	Cottontail
Pinyon-juniper woodland	19	0	5.2	36.8
Chained rangeland	18	0	0	16.7
Bottomland sagebrush	19	0	0	57.9
Lower valleys and agricultural meadows	20	0	0	15

* Percent frequency = (No. of quadrats with tracks/total no. of quadrats) x 100.

Periods of peak activity could not be discerned for the majority of arthropods collected during each survey period. However, it was observed that Lepidopterous larvae were particularly abundant during the months of May and June 1976.

Reptiles and Amphibians

A greater number of lizard species were observed on Grid 1 than on Grid 2. Relative abundance estimates showed that the sagebrush lizard was the most abundant lizard on both grids. Juveniles were numerous in May-June and comprised approximately 50 percent of the populations. No new species were identified.

Birds

In addition to the standard strip transect and qualitative censuses that have been ongoing throughout the environmental program, a thorough search for raptor nests on the Tract was made during late May, and a census of nocturnally active raptors was also conducted. Strip transect censuses conducted along eight transects in mid-April recorded 25 species, of which only six had been encountered during the 1975 spring sampling period (Table II C-3). These disparities in species present from one year to the next indicate that substantial fluxes in avian community composition occur during the prolonged period of spring migration. The 1975 early-spring censuses were conducted during March, at a time when some winter residents were still present; by mid-April, almost all wintering species that nest farther north had departed from the Tract, and some species that will nest in the Piceance Basin had appeared. The continuous change in composition of bird communities during the two principal migratory periods demonstrates the futility of using data on species' density from these periods for quantitative baseline purposes.

During the eighth quarter, censuses of avian communities on Tract C-b occurred between June 17 and June 25, 1976 and between July 21 and July 26, 1976. The major objective was to obtain information on the nesting bird populations within principal tract habitats.

During June field investigations, censusing was accomplished by strip transect procedures within all eight, standard census plots. During July, strip transect procedures were employed in four habitats. Data from these censuses were used to provide estimates of relative abundance of songbird species utilizing habitats on or close to Tract C-b. The water pipit was the only songbird species encountered during the spring sampling period that had not previously been observed on or near Tract C-b. The most abundant species associated with the various vegetative types are shown in Tables II C-3 and II C-4. Transects 4 and 5 are in the pinyon-juniper woodland. Piceance Creek is Transect 2 and open brush communities are Transects 1, 3, and 6. No birds were tallied during spring censuses of the mountain brush habitat above Willow Creek (Transect 8 - Table II C-3).

Table II C-3 Results of Strip Transect Censuses of Birds at Eight Transects During April 1976

	Transect Number															
	1		2		3		4		5		6		7		8	
Species	#/ha*	% RA	#/ha	% RA	#/ha	% RA	#/ha	% RA	#/ha	% RA	#/ha	% RA	#/ha	% RA	#/ha	% RA
Vesper sparrow	0.8	56	0.1	2	0.1	14					0.4	12	0.1	7		
Robin	0.3	19	3.6	61												
Mountain bluebird	0.2	14	0.8	14	0.5	48					0.8	24				
Green-tailed towhee	<0.1	5			<0.1	3					0.1	3				
Dark-eyed junco	<0.1	5			0.3	28	0.4	13			0.8	24				
Common raven	<0.1	1			<0.1	3	<0.1	2	<0.1	1			<0.1	3		
Red-winged blackbird			1.0	18												
Brewer's blackbird			0.1	2												
Song sparrow			0.1	2												
Say's phoebe			<0.1	1												
Scrub jay									<0.1	2			<0.1	3		
House finch							1.5	46	<0.1	2	0.3	9	0.8	55		
Red crossbill							1.0	39	0.4	13			0.3	21		
Evening grosbeak							0.2	5	<0.1	2			0.2	10		
Mountain chickadee							<0.1	3	1.1	31	0.1	3				
Common flicker							<0.1	2	0.2	7						
White-breasted nuthatch							<0.1	1	1.1	31						
Chipping sparrow									<0.1	1						
Plain titmouse									0.2	5						
Black-capped chickadee									<0.1	2						
Pinyon jay									<0.1	2						
Clark's nutcraker									<0.1	1	0.1	3				
Black-billed magpie									<0.1	<1						
Rock wren											0.8	24				
Species diversity (H')	1.253		1.176		1.328		1.387		1.865		1.798		1.305		0.000	
Equitability	0.700		0.604		0.741		0.667		0.707		0.865		0.729		---	

* #/ha = number per hectare; %RA = percentage relative abundance

Table II C-4

RESULTS OF STRIP TRANSECT CENSUSES OF BIRDS AT EIGHT TRANSECTS DURING JUNE 1976

Species	Transect Number															
	1		2		3		4		5		6		7		8	
	#/ha*	%RA**	#/ha	%RA	#/ha	%RA	#/ha	%RA	#/ha	%RA	#/ha	%RA	#/ha	%RA	#/ha	%RA
Mourning dove	0.2	2.1			<0.1	1.1	0.5	9.2	0.5	7.4	0.1	2.2	0.2	4.1		
Common nighthawk							0.1	2.9	<0.1	0.5					0.1	1.6
White-throated swift							<0.1	1.2								
Broad-tailed hummingbird	0.5	7.6	<0.1	0.2	0.4	1.32	0.4	6.9	<0.1	0.7	0.2	4.3	0.4	8.2		
Belted kingfisher			<0.1	0.2												
Common flicker	<0.1	1.2	<0.1	0.2			<0.1	0.3	0.2	2.1	0.1	2.2	<0.1	1.0		
Hairy woodpecker							<0.1	0.3								
Cassin's kingbird			0.3	3.9												
Ash-throated flycatcher	0.3	3.8														
Say's phoebe			<0.1	0.5											0.1	1.6
Dusky flycatcher							0.2	3.5								
Gray flycatcher									0.2	2.1	0.2	3.2			0.2	2.3
Violet-green swallow			0.2	3.2	<0.1	2.2	0.1	2.0	0.1	1.4					0.1	1.6
Rough-winged swallow			0.2	2.4	<0.1	2.2										
Cliff swallow			0.5	7.3			<0.1	1.4			0.2	4.3				
Tree swallow			<0.1	0.2												
Barn swallow			0.1	1.7												
Clark's nutcracker					0.2	5.5	<0.1	0.3	<0.1	0.9						
Common raven	<0.1	0.2					<0.1	0.3								
Steller's jay							<0.1	0.6	<0.1	0.2						
Pinyon jay							<0.1	0.3	1.0	14.2						
Scrub jay									0.1	1.4						
Black-billed magpie									<0.1	0.2						
Mountain chickadee							0.7	11.5	0.4	5.6			0.2	4.1	0.4	6.2
White-breasted nuthatch							0.1	1.7	0.3	3.7						
Plain titmouse									0.2	2.3						
House wren	0.3	4.7	<0.1	0.2	<0.1	1.1			0.4	5.1						
Rock wren					0.1	4.4					0.2	4.3				
Robin			0.2	3.2	<0.1	1.1	0.3	4.6	0.1	0.9	0.2	4.3				
Mountain bluebird	0.7	9.5	0.3	3.9	0.1	3.3	1.1	18.4	0.3	4.7	0.6	12.9	0.4	8.2	0.3	4.7

Table II C-4 (CONTINUED)

Species	Transect Number															
	1		2		3		4		5		6		7		8	
	#/ha*	%RA**	#/ha	%RA	#/ha	%RA	#/ha	%RA	#/ha	%RA	#/ha	%RA	#/ha	%RA	#/ha	%RA
Hermit Thrush							0.3	4.3	0.2	2.8	0.2	3.2				
Blue-gray gnatcatcher	0.1	1.9	<0.1	0.2	0.2	6.6			0.3	3.7					1.2	18.6
Solitary vireo							0.2	2.9	0.2	2.3	0.1	2.2	0.1	2.0		
Black-throated gray warbler									0.7	9.8					0.1	1.6
Virginia's warbler					0.1	3.3					0.2	3.2			1.2	18.6
Western meadowlark			<0.1	0.5												
Red-winged blackbird			2.7	39.0												
Brewer's blackbird			1.1	15.6												
House finch	<0.1	0.5			0.1	3.3	0.1	2.3	0.5	7.0	0.6	12.9	0.2	3.1		
Green-tailed towhee	1.5	20.3			0.1	4.4					0.6	12.9	0.3	6.1	2.1	31.0
Rufous-sided towhee									0.1	1.4	0.2	4.3				
Vesper sparrow	0.9	12.3			0.1	4.4	<0.1	0.6					0.7	14.3		
Black-throated sparrow	0.1	1.9														
Gray-headed junco					<0.1	2.2	0.5	9.2	0.7	9.3	0.8	17.2				
Brewer's sparrow	2.3	32.2	<0.1	0.5	1.3	41.8					0.2	4.3	1.2	24.5	0.3	4.7
Chipping sparrow			<0.1	1.0			1.0	16.1	0.8	10.2	0.1	2.2	1.2	24.5	0.1	1.6
Song sparrow			1.1	15.6												
Hummingbird species	0.1	1.9													0.4	6.2
Species diversity (H')	2.032		1.993		2.120		2.547		2.829		2.570		2.041		2.030	
Equitability (J)	0.770		0.665		0.765		0.812		0.879		0.907		0.851		0.791	

*#/ha = number per hectare

**%RA = percentage relative abundance

In April qualitative field observations (Table II C-5) conducted at a number of locations on the Tract verified the presence of five songbird species not tallied on the quantitative transect censuses. The most frequently encountered species during these qualitative surveys were pinyon jays, robins, and mountain bluebirds.

Of the 47 summer residents recorded on the transects during both series of censuses, three species had not been recorded in previous censuses on the Tract. Only nine of these had not been encountered during the 1975 summer sampling period.

Qualitative surveys were again conducted in the summer. Results complemented those of the quantitative strip transects and the species composition of the Tract habitats as censused by the two techniques was similar. Only five species, not recorded during the June and July strip transects, waterfowl counts, or raptor studies, were noted during qualitative surveys (Table II C-6).

Waterfowl observations of the two impoundments documented the presence of ten waterfowl and shorebird species during April 1976 and both sampling periods in the summer.

In the spring diversity was numerically dominated by the mallard, green-winged teal, and cinammon teal. The ring-necked duck, a waterfowl species not previously recorded on the Tract C-b study area, was observed. The most abundant species during the June investigative period were cinammon teal, green-winged teal, Wilson's phalarope, and killdeer. During July, relative abundance was dominated by green-winged teal, killdeer, and spotted sandpipers.

The common raven, American kestrel, and red-tailed hawk were the most abundant diurnal raptors observed during the spring sampling period, while the great horned owl was the most abundant nocturnal species observed (Tables II C-7 and II C-8). The golden eagle, turkey vulture, and Cooper's hawk were other diurnal species noted, while the screech owl, saw-whet owl, short-eared owl, long-eared owl, and pygmy owl comprised the other nocturnal species recorded.

Thirty-six raptor nests were inventoried during the spring and early summer census period. The common raven and red-tailed hawk were the most frequently observed raptors during June, while the American kestrel was the most abundant species noted during July. The turkey vulture, golden eagle, and sharp-shinned hawk comprised the other raptor species noted. The spring observation of the pygmy owl and the summer observation of the sharp-shinned hawk represented the first record of both these species on the C-b Tract.

Two additional raptor nest sites were discovered during the late spring and summer census periods. All active raptor nests previously encountered on the Tract during 1976 were described in Quarterly Data Report #7.

Table II C-5 RESULTS OF QUALITATIVE COUNT SURVEYS AT TRACT C-b CONDUCTED APRIL 12-17, 1976

Species	Number Tallied	% Relative Abundance *
Mallard	3	2.6
Golden eagle	1	0.9
Red-tailed hawk	1	0.9
Cooper's hawk	1	0.9
American kestrel	1	0.9
Common flicker	5	4.4
Say's phoebe	4	3.5
Rough-winged swallow	1	0.9
Pinyon jay	13	11.4
Common raven	2	1.7
Robin	30	26.3
Townsend's solitaire	1	0.9
Mountain bluebird	22	19.3
Blue-gray gnatcatcher	1	0.9
Red-winged blackbird	10	8.8
Evening grosbeak	4	3.5
House finch	2	1.7
Red crossbill	4	3.5
Vesper sparrow	4	3.5
Dark-eyed junco	1	0.9
Song sparrow	3	2.6
TOTALS	114	100.0

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*Percent Relative Abundance was calculated as:

$$\% \text{ Relative Abundance} = \frac{\text{Number of individuals of species A}}{\Sigma \text{ number of individuals of all species}} \times 100$$

Table II C-6

RESULTS OF STRIP TRANSECT CENSUSES OF BIRDS AT FOUR TRANSECTS DURING JULY 1976

Species	Transect Number							
	1		2		3		4	
	#/ha*	%RA**	#/ha	%RA	#/ha	%RA	#/ha	%RA
Mourning dove							0.5	56.1
Common flicker	0.1	9.9	<0.1	0.7			<0.1	1.8
Say's phoebe			0.3	11.0				
Barn swallow			0.1	5.5				
Cliff swallow			0.5	20.5				
Rough-winged swallow			<0.1	0.7				
Mountain chickadee							0.2	21.1
White-breasted nuthatch							0.1	14.0
House wren	0.1	11.3			0.1	11.8		
Rock wren					0.2	17.6		
Robin			<0.1	0.7				
Mountain bluebird	<0.1	2.8	<0.1	1.4				
Blue-gray gnatcatcher	0.1	8.5						
Red-winged blackbird			1.1	43.8				
House finch			<0.1	2.7				
Vesper sparrow	0.8	67.6	<0.1	2.1				
Chipping sparrow							<0.1	7.0
Brewer's sparrow					0.8	70.6		
Song sparrow			0.3	11.0				
Species diversity (H')	1.048		1.670		0.804		1.185	
Equitability (J)	0.651		0.696		0.732		0.736	

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[*] #/ha = numbers per hectare

[**] %RA = percentage relative abundance

Table II C-7 RESULTS OF NIGHT OWL TRANSECT CONDUCTED MAY 28, 1976

Species	Total Individuals Tallied	% Relative Abundance*
Great horned owl	4	26.7
Screech owl	5	33.3
Long-eared owl	2	13.3
Short-eared owl	1	6.7
Saw-whet owl	2	13.3
Pygmy owl	1	6.7
TOTAL	15	100.0

*% Relative Abundance was calculated as:

$$\% \text{ Relative Abundance} = \frac{\text{Number of individuals of species A}}{\Sigma \text{ Number individuals of all species}} \times 100$$

Table II C-8 DIURNAL RAPTORS NOTED ON OR CLOSE TO TRACT C-b DURING THE SPRING, 1976 SAMPLING PERIOD

Species	Total Individuals Tallied*	% Relative Abundance**
Golden eagle	4	9.5
Red-tailed hawk	14	33.3
Turkey vulture	2	4.8
Cooper's hawk	1	2.4
American kestrel	10	23.8
Common raven	11	26.2
TOTAL	42	100.0

*This is the estimated number of individuals of each species thought to have been on the tract during the spring sampling period. These numbers are based on number of active nests, distinct characteristics of individuals, areas of observation, available literature on breeding territories of raptors, and observations of more than one individual of a species at a time. These are conservative estimates and probably underestimate the numbers of raptors actually breeding in the area.

**% Relative Abundance was calculated as :

$$\text{\% Relative Abundance} = \frac{\text{Total estimated number of individuals of species A}}{\text{Total estimated number of raptors}} \times 100$$

Twenty-nine raptor pellets were collected from roosting stations during April and were analyzed during this reporting period. Pellets were predominantly from great horned owls. Pocket gophers were the principal constituent of prey species consumed by the Tract's great horned owl population during this period. Pellets were not collected from active nesting sites so as to avoid unnecessary harassment to nesting raptors. Two hundred fourteen raptor pellets were collected from active nesting sites and roosting stations during May and are currently being analyzed.

Sixty-eight species were tallied during field census activities conducted during June and July, 1976. A total of 136 bird species have been documented since field sampling was initiated in early October, 1974.

II C-2 Aquatic Studies

The aquatic studies for this quarter included bimonthly collections of fish, benthos, periphyton, water samples, sediment samples, springs and seeps, and plankton. Samples were collected in July. Flash flood conditions in Piceance Basin several days prior to sampling caused severe flooding. The stream levels had returned to a normal level by the sampling period. Upper Stewart Lake (USL) had dried up and was not sampled.

Fish

No new fish species were collected during this quarter. The mountain sucker, speckled dace, brook trout, and mottled sculpin were collected. Two tagged brook trout were recaptured.

Benthos

Benthic invertebrates were represented by three phyla: Annelida, Arthropoda, and Mollusca. The Arthropods were most abundant.

Periphyton

Diatoms were the most numerous periphyton species collected in July. Periphyton primary productivity was not completed in time for inclusion in this report.

Plankton Primary Productivity

Phytoplankton primary productivity was measured in July using the light and dark bottle method in the lakes. Results were not completed for inclusion in this report.

Water Quality

Water quality samples were analyzed for common minerals and nutrients, total hardness, total alkalinity, total dissolved solids, bacteria, and pathogens. For most stations sampled, total dissolved solids had increased in July. No disease pathogens were detected in the samples from the stations examined.

Sediment

Selected stations were examined for grain size analysis. There was a decrease in fine sediment particles in July except for the downstream station in Piceance Creek.

Springs and Seeps

Springs and seeps were examined in July. Invertebrates collected were generally found at the other aquatic sampling stations.

Plankton

Plankton samples were collected at all stations and preserved. Plankton samples were not analyzed for this report.

II C-3 Terrestrial Vegetation Studies

Introduction

The material contained in this quarterly report constitutes a progress report on the activities conducted during the 1976 growing season. During this period the field studies for the baseline vegetation program have been completed, however, much of the data remain to be tabulated (dry weights for clip samples and observations made late in the growing season).

Intensive Plot Studies

During June frequencies for all herbaceous species were recorded in the intensive study-site permanent-quadrat grids. In September the shrub transects, which were originally sampled in 1974, were re-sampled, and at the same time the marked trees were re-measured. The purpose for re-sampling these sites was to allow for evaluation of the amount of differences which can be expected in these vegetation parameters during non-development conditions. Since these parameters are designed to be monitored for a long time period, it is important to have these comparative data.

Herbaceous Production Studies

Herbaceous standing crop samples were clipped in June in the bottomland sagebrush community (Plot 3) and at all plots (except Plot 3) in July. Differences in clip dates relate to times of peak standing crop. Final clips were made in August at all sites. Samples from April, May, and June have been dried and weighed; samples from July and August are still being processed.

Shrub Production Studies

Shrub samples will be clipped in mid-September to provide an estimate of shrub standing crop at the end of the growing season. Samples are currently being dried and weighed.

Phytosociological Sampling Program

During July a representative stand of mixed mountain shrub was sampled to provide an estimate of herbaceous species frequencies and shrub species cover, frequency, and density. Data on this community type have not been collected during the 1975 growing season.

Herb Phenology Studies

Observations on the phenological state of major herb species have continued through the growing season. These data have been collected at the intensive study sites.

Litter and Decomposition Studies

Litter samples from the bottomland sagebrush plot and the woodland plots were collected in September. Evaluation of these data in conjunction with earlier collected data will allow for estimation of rate of litter production.

Decomposition samples were retrieved from the intensive study plots in September.

Marked Twig Measurements

Marked twigs at all intensive study plots were measured in mid-September. Comparison of lengths obtained in May will allow for estimation of growth during the 1976 season.

II C-4 Soil Survey and Productivity Assessment

II D GEOLOGY

The surface geology report was presented in Quarterly Data Report #5 and in the Annual Summary and Trends Report. Data pertaining to surface geology will be integrated, as it applies to other studies, within Section II E - Ecological Interrelationships.

II E ECOLOGICAL INTERRELATIONSHIPS

The section on Ecological Interrelationships was introduced in the Annual Summary and Trends Report and expanded upon in Summary Report #6. Continuing study of this area has not progressed to the point that additional reports can be made in this summary report.

III

OTHER STUDIES

As indicated in Quarterly Data Report #6, only active programs in this category will be reported. During this quarter, other studies in the active state include the Revegetation Program and the Microenvironmental Program.

III A FISH AND WILDLIFE MANAGEMENT PLAN - Completed

III B REVEGETATION PROGRAM

No revegetation was accomplished on Tract C-b or the surrounding one-mile study area during the 8th quarter.

Future activities include the physical preparation and revegetation of the road cut to SG-20 (A-6). Plans for this effort have been formulated and submitted to the Bureau of Land Management for approval. Pending approval, the first stage of this work - preparation of the seed bed and seeding - will be done in October of this year. The second stage of this work calls for the planting of shrub sets in the spring of 1977.

The evaluation of the fall, 1975 revegetation program is planned for the fall of this year. The drill pads and access roadways will be sampled to determine percent cover by herbaceous and shrub species (<.25 m high), percent cover by rock, soil, litter, mosses and lichens, and determine herbaceous standing crop. The results of this sampling will be presented in the next reporting period.

III C MICROENVIRONMENTAL PROGRAM

Microenvironmental data collected during March through May, 1976, quarter are summarized in Tables III C-1 through III C-3. The significant features of this period were relatively high spring precipitation, (especially in comparison with 1975 March-May precipitation), increasing daytime temperatures, and the occurrence of hard frosts through May.

The lowest absolute air temperature during the period was -22°C (Table III C-4), recorded in the chained rangeland site in March. The maximum temperature recorded during the period, 25°C, occurred in May in the upland sagebrush site. Average free air temperatures recorded at one meter above the surface were 1.6°C in March, 3.8°C in April, and 6.6°C in May.

The minimum recorded surface temperature was -12°C, occurring in April in the chained pinyon-juniper rangeland site. The maximum temperature recorded at the ground surface was 50°C. This temperature was recorded during May in the bottomland sagebrush site. Average temperatures at the ground surface were 0.2°C in March, 4.4°C in April, and 15.0°C in May. Diurnal variations in temperature are well-developed during this period and frosts were common through May.

Average total precipitation for all stations for the entire period was 3.1 cm, occurring predominantly as rain. May received the least precipitation with a 13-station average total of 2.5 cm. March received the most precipitation with an average of 3.8 cm of precipitation. During April 2.9 cm of precipitation fell. The significant amounts of moisture falling during this period are reflected by soil moisture trends. Soil moisture increased through April in most sites. The soil moisture values for bottomland sagebrush sites did not appear to be affected directly by increased precipitation; this might be attributed to increased permeability of soil, increased uptake of water by big sagebrush, or a combination of these two factors. Soil moisture decreased in May as did precipitation. However, lowered soil moisture might well be more influenced by water use of vegetation resuming growth than by less precipitation.

Wind speeds in each of the four major vegetation types are greater than during the fall and winter periods. Upland sagebrush wind speeds averaged 9.0 km/hr vs 8.3 km/hr during the fall and winter. Wind speeds in the chained rangeland and the bottomland sagebrush sites averaged 3.2 km/hr. Woodland sites, as has been the trend, experienced the lightest winds at average speeds of 2.1 km/hr. Prevailing wind direction in the chained rangeland site was southwesterly. At all other sites prevailing winds were southerly to southeasterly. Wind speeds generally increased through April, declining toward late spring and early summer.

Realative humidity averages 51 percent for the period. May values were highest at 56 percent; April values averaged 55 percent, while March values averaged 42 percent.

Table III C-1
MICROENVIRONMENTAL STATIONS
MARCH, 1976
MONTHLY SUMMARY

STATION NUMBER	SOIL TEMPERATURE °C			AIR TEMPERATURE °C					SOIL MOISTURE %			PRECIPITATION, Total cm*	RELATIVE HUMIDITY, %	WIND SPEED MPH		WIND DIRECTION °Azimuth		NET SOLAR RADIATION, Langleys	VEGETATION TYPE AND LOCATION
	-60 cm	-40 cm	-20 cm	0 cm	1 meter	3 meters	Minimum, Absolute	Maximum, Absolute	-60 cm	-40 cm	-20 cm			1 meter	3 meters	1 meter	3 meters		
1	▨	▨	( )	▨	▨	▨	-21	15	▨	▨	77	4.1	35	▨	▨	▨	▨	▨	CHAINED PINYON-JUNIPER RANGELAND (Vegetation Plot #1)
2	▨	▨	( )	▨	▨	▨	-13	11	▨	▨	85	4.6	72	▨	▨	▨	▨	▨	CHAINED PINYON-JUNIPER RANGELAND (Vegetation Plot #2)
3@	1.47	2.25	0.87	0.47	-1.53	▨	-16.0	12.5	71	72	77	9.22	45	5.84	▨	130	▨	▨	UPLAND SAGEBRUSH (Vegetation Plot #3)
4@	2,94	2.54	2.43	2.38	-0.72	▨	-21.5	17	44	48	42	0.00	49	1.34	▨	141	▨	▨	BOTTOM LAND SAGEBRUSH (Vegetation Plot #4)
5	▨	▨	( )	▨	▨	▨	-20	14	▨	▨	77	3.2	( )	▨	▨	▨	▨	▨	PINYON-JUNIPER WOODLAND (Vegetation Plot #5)
6@	-0.59	-1.03	-1.35	-1.78	-2.24	▨	-17	11.5	80	62	76	2.63	39	1.35	▨	172	▨	▨	PINYON-JUNIPER WOODLAND (Vegetation Plot #6)
7@	( )	1.01	-0.14	-0.12	-1.92	( )	-22.2	10.4	75	72	62	( )	68	1.92	( )	217	( )	( )	CHAINED PINYON-JUNIPER RANGELAND (Animal Trapping Grid #1)
8	▨	▨	( )	▨	▨	▨	-19	23	▨	41	57	2.4	41	▨	▨	▨	▨	▨	BUNCHGRASS COMMUNITY (South-Facing Slope)
9	▨	▨	( )	▨	▨	▨	-25	15	22	22	28	2.9	28	▨	▨	▨	▨	▨	BOTTOM LAND SAGEBRUSH (Mouth of Sorghum Gulch)
10	▨	▨	( )	▨	▨	▨	-21	15	( )	67	60	4.1	28	▨	▨	▨	▨	▨	RABBITBRUSH COMMUNITY (Mouth of West Stewart Gulch)
11	▨	▨	( )	▨	▨	▨	-23	13	▨	▨	88	2.3	36	▨	▨	▨	▨	▨	BUNCHGRASS COMMUNITY (West-Facing Talus Slope)
12	▨	▨	( )	▨	▨	▨	-24	10	28	27	29	5.1	30	▨	▨	▨	▨	▨	BOTTOM LAND SAGEBRUSH (Alluvial Site)
13	▨	▨	( )	▨	▨	▨	-10	9	( )	39	43	4.8	29	▨	▨	▨	▨	▨	MIXED MOUNTAIN SHRUBLAND (North-Facing Slope)
14	▨	▨	( )	▨	▨	▨	-22	14	33	34	35	3.0	32	▨	▨	▨	▨	▨	PINYON-JUNIPER WOODLAND (West-Facing Slope)
15	▨	▨	( )	▨	▨	▨	-15	10	▨	82	72	3.0	40	▨	▨	▨	▨	▨	PINYON-JUNIPER WOODLAND (Cottonwood Gulch)
16	▨	▨	( )	▨	▨	▨	( )	( )	36	35	61	3.4	44	▨	▨	▨	▨	▨	UPLAND SAGEBRUSH (Head of Sorghum Gulch)
17	▨	▨	( )	▨	▨	▨	-24	13	28	30	51	3.0	49	▨	▨	▨	▨	▨	ANNUAL WEED COMMUNITY (Abandoned Drill Pad)

@ Continuous Recording Stations
* Precipitation Values Are Totals For Period, Minimum And Maximum Temperature Values Are Absolute; All Other Values Are Expressed As Means
▨ Values Not Measured At These Stations
() Values Not Available For This Period Due To Instrument Failure

Table III C-2
MICROENVIRONMENTAL STATIONS
APRIL, 1976
MONTHLY SUMMARY

STATION NUMBER	SOIL TEMPERATURE °C			AIR TEMPERATURE °C					SOIL MOISTURE %			PRECIPITATION, Total cm*	RELATIVE HUMIDITY, %	WIND SPEED MPH		WIND DIRECTION °Azimuth		NET SOLAR RADIATION, Langleys	VEGETATION TYPE AND LOCATION
	-60 cm	-40 cm	-20 cm	0 cm	1 meter	3 meters	Minimum, Absolute	Maximum, Absolute	-60 cm	-40 cm	-20 cm			1 meter	3 meters	1 meter	3 meters		
1	▨	▨	( )	▨	▨	▨	-18	19	▨	▨	74	( )	( )	▨	▨	▨	▨	▨	CHAINED PINYON-JUNIPER RANGELAND (Vegetation Plot #1)
2	▨	▨	( )	▨	▨	▨	-16	18	▨	▨	76	( )	( )	▨	▨	▨	▨	▨	CHAINED PINYON-JUNIPER RANGELAND (Vegetation Plot #2)
3@	2.76	( )	2.97	3.90	3.74	▨	-10.5	20.5	42	45	63	4.90	( )	6.01	▨	157	▨	▨	UPLAND SAGEBRUSH (Vegetation Plot #3)
4@	3.37	3.32	3.77	4.59	4.50	▨	-14.0	28.0	50	57	64	.00	( )	1.65	▨	134	▨	▨	BOTTOM LAND SAGEBRUSH (Vegetation Plot #4)
5	▨	▨	( )	▨	▨	▨	-15	17	▨	▨	63	( )	( )	▨	▨	▨	▨	▨	PINYON-JUNIPER WOODLAND (Vegetation Plot #5)
6@	1,91	1,97	2,42	3,88	2,85	▨	-14.0	19.5	60	62	69	.79	( )	1.31	▨	172	▨	▨	PINYON-JUNIPER WOODLAND (Vegetation Plot #6)
7@	( )	3,46	3,72	5,20	3,96	( )	-12.0	19.9	76	70	65	( )	55	2.25	( )	203	( )	( )	CHAINED PINYON-JUNIPER RANGELAND (Animal Trapping Grid #1)
8	▨	▨	( )	▨	▨	▨	-14	30	▨	41	46	2.16	( )	▨	▨	▨	▨	▨	BUNCHGRASS COMMUNITY (South-Facing Slope)
9	▨	▨	( )	▨	▨	▨	-16	26	36	38	49	( )	( )	▨	▨	▨	▨	▨	BOTTOM LAND SAGEBRUSH (Mouth of Sorghum Gulch)
10	▨	▨	( )	▨	▨	▨	-15	27	64	64	55	( )	( )	▨	▨	▨	▨	▨	RABBITBRUSH COMMUNITY (Mouth of West Stewart Gulch)
11	▨	▨	( )	▨	▨	▨	-17	18	▨	▨	40	( )	( )	▨	▨	▨	▨	▨	BUNCHGRASS COMMUNITY (West-Facing Talus Slope)
12	▨	▨	( )	▨	▨	▨	-16	14	28	31	49	( )	( )	▨	▨	▨	▨	▨	BOTTOM LAND SAGEBRUSH (Alluvial Site)
13	▨	▨	( )	▨	▨	▨	-14	13	( )	39	62	( )	( )	▨	▨	▨	▨	▨	MIXED MOUNTAIN SHRUBLAND (North-Facing Slope)
14	▨	▨	( )	▨	▨	▨	-17	19	46	77	79	( )	( )	▨	▨	▨	▨	▨	PINYON-JUNIPER WOODLAND (West-Facing Slope)
15	▨	▨	( )	▨	▨	▨	-17	19	▨	74	84	( )	( )	▨	▨	▨	▨	▨	PINYON-JUNIPER WOODLAND (Cottonwood Gulch)
16	▨	▨	( )	▨	▨	▨	-13	5	81	80	76	( )	( )	▨	▨	▨	▨	▨	UPLAND SAGEBRUSH (Head of Sorghum Gulch)
17	▨	▨	( )	▨	▨	▨	-19	20	( )	70	60	3.56	( )	▨	▨	▨	▨	▨	ANNUAL WEED COMMUNITY (Abandoned Drill Pad)

@ Continuous Recording Stations
* Precipitation Values Are Totals For Period, Minimum And Maximum Temperature Values Are Absolute; All Other Values Are Expressed As Means
▨ Values Not Measured At These Stations
() Values Not Available For This Period Due To Instrument Failure

Table III C-3
MICROENVIRONMENTAL STATIONS
MAY, 1976
MONTHLY SUMMARY

STATION NUMBER	SOIL TEMPERATURE °C			AIR TEMPERATURE °C					SOIL MOISTURE %			PRECIPITATION, Total cm*	RELATIVE HUMIDITY, %	WIND SPEED MPH		WIND DIRECTION °Azimuth		NET SOLAR RADIATION, Langleys	VEGETATION TYPE AND LOCATION
	-60 cm	-40 cm	-20 cm	0 cm	1 meter	3 meters	Minimum, Absolute	Maximum, Absolute	-60 cm	-40 cm	-20 cm			1 meter	3 meters	1 meter	3 meters		
1	▨	▨	( )	▨	▨	▨	-8	28	▨	▨	70	.79	( )	▨	▨	▨	▨	▨	CHAINED PINYON-JUNIPER RANGELAND (Vegetation Plot #1)
2	▨	▨	(13)	▨	▨	▨	-10	29	▨	▨	52	1.52	( )	▨	▨	▨	▨	▨	CHAINED PINYON-JUNIPER RANGELAND (Vegetation Plot #2)
3@	6.37	( )	7.58	10.49	6.43	▨	-7.0	20.5	67	69	73	6.30	100	4.83	▨	144	▨	▨	UPLAND SAGEBRUSH (Vegetation Plot #3)
4@	6.81	7.86	9.12	10.91	6.76	▨	-7	25.0	53	61	58	( )	( )	2.91	▨	174	▨	▨	BOTTOM LAND SAGEBRUSH (Vegetation Plot #4)
5	▨	▨	( )	▨	▨	▨	-7	27	▨	▨	42	.97	100	▨	▨	▨	▨	▨	PINYON-JUNIPER WOODLAND (Vegetation Plot #5)
6@	6.29	6.86	7.78	10.34	6.67	▨	-5.5	23.0	55	57	64	1.68	( )	1.21	▨	182	▨	▨	PINYON-JUNIPER WOODLAND (Vegetation Plot #6)
7@	( )	6.67	7.25	9.36	6.45	( )	-8.6	33.4	73	65	58	( )	64	1.92	( )	220	( )	( )	CHAINED PINYON-JUNIPER RANGELAND (Animal Trapping Grid #1)
8	▨	▨	(18)	▨	▨	▨	-4	34	▨	42	44	.91	21	▨	▨	▨	▨	▨	BUNCHGRASS COMMUNITY (South-Facing Slope)
9	▨	▨	( )	▨	▨	▨	-7	27	41	41	43	2.01	( )	▨	▨	▨	▨	▨	BOTTOM LAND SAGEBRUSH (Mouth of Sorghum Gulch)
10	▨	▨	( )	▨	▨	▨	-10	30	58	58	48	.91	26	▨	▨	▨	▨	▨	RABBITBRUSH COMMUNITY (Mouth of West Stewart Gulch)
11	▨	▨	( )	▨	▨	▨	-8	28	▨	▨	37	2.54	26	▨	▨	▨	▨	▨	BUNCHGRASS COMMUNITY (West-Facing Talus Slope)
12	▨	▨	( )	▨	▨	▨	-9	30	38	39	43	.81	( )	▨	▨	▨	▨	▨	BOTTOM LAND SAGEBRUSH (Alluvial Site)
13	▨	▨	( )	▨	▨	▨	-7	29	44	61	59	1.19	( )	▨	▨	▨	▨	▨	MIXED MOUNTAIN SHRUBLAND (North-Facing Slope)
14	▨	▨	( )	▨	▨	▨	-6	25	48	59	54	.69	( )	▨	▨	▨	▨	▨	PINYON-JUNIPER WOODLAND (West-Facing Slope)
15	▨	▨	( )	▨	▨	▨	-7	31	▨	64	60	1.40	( )	▨	▨	▨	▨	▨	PINYON-JUNIPER WOODLAND (Cottonwood Gulch)
16	▨	▨	(18)	▨	▨	▨	-8	24	73	71	64	8.00	( )	▨	▨	▨	▨	▨	UPLAND SAGEBRUSH (Head of Sorghum Gulch)
17	▨	▨	( )	▨	▨	▨	-10	27	( )	65	52	3.43	( )	▨	▨	▨	▨	▨	ANNUAL WEED COMMUNITY (Abandoned Drill Pad)

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▨ Values Not Measured At These Stations
() Values Not Available For This Period Due To Instrument Failure

TABLE III C-4

MEAN AND ABSOLUTE MINIMUM AND MAXIMUM TEMPERATURES (^{o}C) AT THE SURFACE AND AT 1 METER, MARCH THROUGH MAY, 1976

			UPLAND SAGEBRUSH		BOTTOMLAND SAGEBRUSH		PINYON-JUNIPER WOODLAND		CHAINED PINYON-JUNIPER RANGELAND	
			SURFACE	AIR	SURFACE	AIR	SURFACE	AIR	SURFACE	AIR
MARCH	Mean	Max								
		Min								
	Absolute	Max	2.0	12.5	4.0	17.0	8.0	11.5	13.7	9.9
		Min	-0.5	-15.5	0.5	-20.5	-5.0	-16.5	-6.9	-22.2
APRIL	Mean	Max								
		Min								
	Absolute	Max	41.5	20.5	38.5	24.5	43.5	19.5	29.7	19.9
		Min	-4.5	-10.0	-7.0	-11.5	-9.5	-12.5	-12.0	-11.3
MAY	Mean	Max								
		Min								
	Absolute	Max	49.5	25.0	50.0	24.0	46.5	23.0	31.0	21.4
		Min	-6.5	-7.0	-6.0	-7.0	-5.5	-5.5	-9.6	-8.1

Form 1279–3
(June 1984)

BORROWER'S C

TN 859 .C64 C37
C-b Shale Oil Pr
Tract C-b: summa

DATE LOANED	BORROWER

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